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# A SUMMARY OF SPECTRUM UTILIZATION AND A FREQUENCY ALLOCATION PLAN FOR THE INTEGRATED COMMUNICATIONS NAVIGATION IDENTIFICATION (CNI) SYSTEM

J. Clapper, Jr.



AUGUST 1971

Prepared for

DEPUTY FOR PLANNING AND TECHNOLOGY
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts




Project 6910
Prepared by
THE MITRE CORPORATION
Bedford, Massachusetts
Contract F19(628)-71-C-0002

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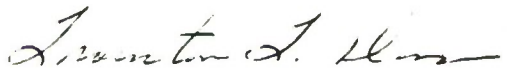
## FOREWORD

This report was prepared under Contract F19(628)-71-C-0002, Project 6910, by The MITRE Corporation, Bedford, Massachusetts for the Air Force Systems Command, Electronic Systems Division, L. G. Hanscom Field, Bedford, Massachusetts.

## REVIEW AND APPROVAL

Publication of this technical report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.



THORNTON T. DOSS, Colonel, USAF
Chief, Communications Development Div.
Deputy for Planning and Technology

ABSTRACT

Utilization of the radio frequency spectrum from 108 MHz to 1660 MHz for airborne radio navigation, air traffic control, and related communications and identification (CNI) purposes is examined with a view to identifying the most appropriate course of action to be followed in obtaining radio frequency allocations. On the basis of political, economic and electromagnetic compatibility considerations, combined with the necessity for the evolutionary introduction of CNI, an initial decision to concentrate TACAN operations on a lesser number of channels and reassigning the vacated spectrum space to CNI appears feasible in the 960-1215 MHz Aeronautical Radionavigation band. The 1535 MHz - 1660 MHz portion of the spectrum appears attractive for an ultimate consolidation of space/aeronautical mobile and CNI concepts. Formal frequency allocation action at the United States national level to support these judgments is urged.

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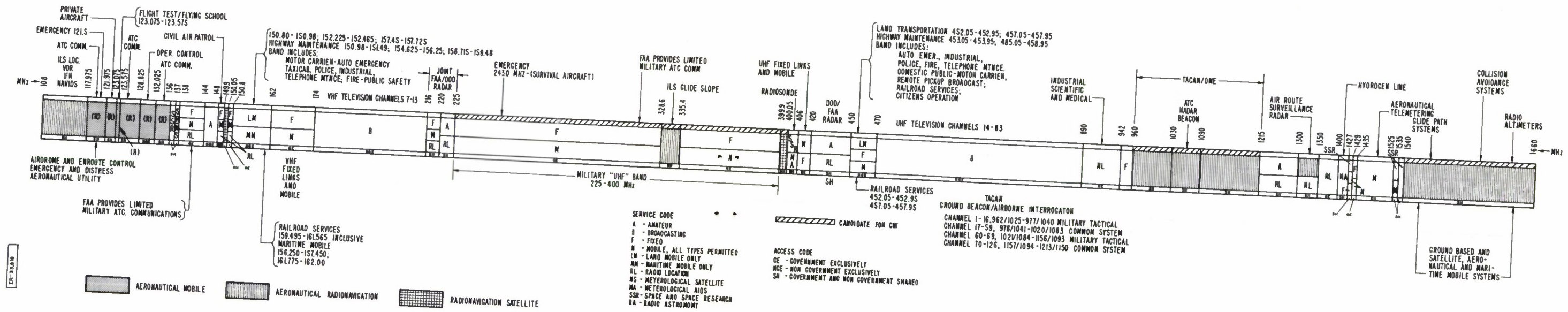



Figure 1. U.S. NATIONAL ELECTROMAGNETIC SPECTRUM ALLOCATIONS 108-1660 MHz
(NOT TO SCALE)

# SECTION I

# INTRODUCTION

## 1.1 General

This paper has been written in response to the recognition of the need for crystalization of opinion to support U. S. national radio frequency allocation planning for a consolidated system of aeronautical radio navigation, communications and identification (CNI). A great deal of activity is now going on in the search for the best technological solution to the CNI requirement. The question of how to avoid the pitfalls of electromagnetic non-compatibility is being examined, insofar as it pertains to the experimental introduction of CNI test hardware into the so-called TACAN radio frequency band extending from 960 MHz to 1215 MHz.

While such an explicit investigation is vital to the efficient introduction of CNI into the TACAN band, if that portion of the spectrum were to be ultimately chosen as the proper place for operational CNI, it must be stated that no final decision has been reached as to whether or not the TACAN band is to be the proposed recipient of this budding new system. In short, it may be said that the concept development studies, preliminary design activities, experimental and analytical efforts now going forward are intended to favor in the end those allocation conditions which promise the best probability of acceptance and agreement by both the U. S. national and the International community of spectrum management authorities.

It is inherent to the research and analysis now being undertaken at MITRE that efficient use of the spectrum is to be maximized, within the limits of system performance requirements. CNI must be afforded a "home" in the spectrum where it can compatibly exist i.e., free of harmful interference as well as not jeopardize the operational rights and needs of others. The portion of the spectrum considered in this paper, 108 MHz to 1660 MHz, is illustrated in Figure 1.

## 1.2 Spectrum Usage

This report contains a summary of the current and projected spectrum utilization in the 108 MHz-136 MHz, 225 MHz-400 MHz, 960 MHz-1215 MHz and 1535 MHz-1660 MHz bands. It covers the present regulatory status, application, state of congestion, as well as the nature of the operations and techniques in use in each

of these bands. It discusses the investment in, and the complexity of the systems currently operational so that an analysis may be made as to the positive and negative factors existing in each case as to sharing or co-utilization of the band.

Each of the bands is evaluated on a relative basis on comparison to the others listed. Finally, this paper takes an independent perspective as to the feasibility of adoption of a specific course of action for future efforts to obtain formal allocations for CNI. It is not possible to postpone this aspect of the matter until such time as all the technical parameters of CNI have fallen nicely into place. However, no judgment is intended here as to the relative merits of alternative system parameters which are independent of spectrum considerations.

It is a hard reality that a coterie of sometimes divergent and always critical entities make up the forum in which frequency allocation proposals are considered. The claimants for new allocations are competing for a very limited resource. No proposal will be well received by all sides, and each will examine it critically to expose any flaws or incompatibility. Thus, it behooves the CNI proponents to be aware of the sensitive nature of the allocation process, and to realistically proceed in an enlightened fashion to gain the most from it.

SECTION II

# THE IMPACT OF INTERNATIONAL TELECOMMUNICATIONS UNION (ITU) RADIO REGULATIONS ON CNI FREQUENCY ALLOCATION PLANNING

## 2.1 Understanding the Regulations

The International Telecommunications Union (ITU) is the organization which periodically meets in formal convention to compose and revise its "Radio and Telephone Regulations", which are ratified by the 134 or more member nations and subsequently used to govern international radio frequency spectrum allocations and usage. The most recent ITU World Conference was held in 1967, and its ratified "Radio Regulations" were published in 1968. These Radio Regulations define terminology, establish rules for the assignment and use of frequencies, allocate frequencies to the various specified "services" by use of an Allocation Table with footnotes, as well as set forth nearly 1000 pages of detail upon the various resolutions and regulations agreed upon by the ITU member nations. Certain pertinent portions of the 1968 ITU Radio Regulations are appended hereto. (See Appendix I). It is suggested that the readers of this report have an understanding of the Regulations and their application.

The provisions of the Regulations, by virtue of having been ratified by the ITU member nations, have the status of International Law. It is customary for the member nations to interpret the Regulations in two ways. First, through the Footnotes to the Frequency Tables in Article 5 of Chapter II. Each footnote is cited with respect to a specific portion of the allocation table. For example, Footnote 351 states, "In Italy the band 1534-1660 MHz is also allocated to the fixed service until 1 January 1970". Second, through national allocation tables such as are published by the U. S. FCC. This latter type of table is used to further specify allocations that apply solely within the issuing nation.

Various nations interpret the Regulations differently, in their own best interests. In the fields of aeronautical radionavigation and aeronautical mobile services, particularly within the non-communist block of nations, a general unanimity of allocation policy pervades. Such groups as the International Civil Aviation Organization (ICAO) work diligently to insure that international aviation is not penalized through arbitrary national allocation actions contrary to their common interests.

As was mentioned earlier, a nation occasionally takes an allocation position which does not conform to the ITU Regulations. Such a national provision is said to be "in derrogation of the treaty". When such actions do occur, usually there is a complaint registered by some other nation with the ITU Secretariat. Then, at the next ITU Convention, strong efforts are undertaken to resolve these differences and to avoid them in the future. General Rule #115-3 is quoted to illustrate the degree to which derrogations are opposed:

> "115-3. Administrations of the members and Associate Members of the Union shall not assign to a station any frequency in derrogation of either the Table of Frequency Allocations given in this Chapter (II) or the other provisions of these Regulations, except on the express condition that harmful interference shall not be caused to services carried on by stations operating in accordance with the provisions of the Convention and of these Regulations."

## 2.2 Rights Based Upon Allocation Status

The impact of the existing ITU Radio Regulations can therefore be said to be firm and precise. Every radio station operates in a specifically designed "service", and in accordance with explicitly worded and regionally defined and applicable allocation tables, clearly footnoted to avoid any confusion or misunderstanding, on frequencies assigned formally by the government of the nation in which the station transmitter is located.

Equally important is the process of resolving differences at ITU World conventions. Every aspect of all the national proposals are carefully considered during the long and detailed meetings which weigh the pros and cons of divergent views, and finally the majority interest prevails. Each nation has but a single vote. This forces the separate views within a national delegation to be resolved before it can cast its vote. If, for example, there were to be several views as to how the U. S. Delegate should cast his vote on the rewording of a footnote, allocation, or any other part of the Regulations, these would of necessity have to be resolved prior to casting a vote. The members of each national delegation are of course predisposed towards their agencies of origin, and are often recognized as authorities in their own right. The process of arriving at the final U. S. national position, as is represented by the votes taken at the Convention, is democratic and fair.

## 2.3 The 1971 ITU World Administrative Radio Conference for Space Telecommunications.

This report has been written only a few months before the opening of the 1971 ITU World Administrative Radio Conference, which will determine the form and content of the next edition of the ITU Radio Regulations, to be in effect from the summer of 1971 until there is again an upgrading, later in the 1970-80 decade. When the new table is approved by the delegates to the convention, each nation will be faced with adjusting its national tables to conform to it, or "derrogating". This latter possibility is not at all practicable in the aeronautical services, since aircraft cannot be expected to operate in one region using one set of equipments and practices, while having to operate in another region in a different way with different hardware and procedures. Moreover, this eventuality is unlikely because of the influence exerted by such bodies as the ICAO.

There is nothing haphazard about the preparation the United States makes before it sends a delegation to an ITU World Radio Conference. The roots of every subject in the U. S. position go back to the national authorities upon whose opinions and judgement the final position is based. These national authorities have also been in close contact with their counterparts in other nations. It is typical and characteristic of these international Associations that they offer a forum for the presentation of ideas which either gain favor or lose support. Both nationally and internationally, opposing and factional views emerge and are assessed, and in the end the products of these deliberations are melded. Their influence upon the developing U. S. positions for ITU World conferences is great.

## 2.4 Preliminary vs. Planning for ITU World Conferences

The United States delegation to ITU World Radio Conventions has in the past benefited from having had strong representation from the U. S. aeronautical community. The 1971 ITU World Radio Administrative Conference will benefit in a similar fashion. Thus, the operational users are directly involved in the making of policies under which they must later work. Quite a bit of the preliminary planning in their area of interest is accomplished through special international and national organizations directly involved with aviation operations and plans. Among these specialized bodies, the International Civil Aviation Organization (ICAO) is perhaps the most vital, since it enjoys a very high level of membership from the nations most active in aviation. The

airlines of the world, whose routes cross international boundaries have joined into a second influential body, the International Air Transport Association (IATA). U. S. representatives to the IATA spring from the U. S. Air Transport Association (ATA). Aeronautical Radio, Incorporated (ARINC), as the principal private radio operating company serving the U. S. airlines, plays a strong part in any U. S. radio frequency policy discussion. ARINC has regularly performed the radio frequency engineering work related to the uses of the spectrum by its members, and as a result, has had a long and highly technical relationship with the FCC, the FAA, NASA, and the Department of State. The Interagency Group on International Avaiation (IGIA), working closely with the FAA and NASA, serves to assist in the coordination of international aviation problems among U. S. governmental departments, bureaus and agencies. The Radio Technical Commission for Aeronautics (RTCA) provides a forum for government and industrial discussions. Within the U. S. Executive branch of government, the Director of Telecommunications Policy, reporting to the President, is charged with coordination of all U. S. government use of the radio frequency spectrum. His action agency is the Interdepartment Radio Advisory Committee (IRAC). There is direct and continuous coordination between the IRAC and the FCC. The Department of Defense provides three members to the IRAC. (Each other major government Department is represented by a single member). In the past, the IRAC has taken a strong role in U. S. national radio frequency policy formulation.

## 2.5 Bringing CNI into the ITU Scene

Here then, it can be seen that the CNI research and development effort must take in to account the views and plans of the major operational and policy making bodies that are directly involved with worldwide and U. S. national frequency allocation policy. As terms, CNI, UCNI or ICNI have had no formal definition or ITU evaluation. The subject of CNI is not on the agenda of the 1971 ITU World Administrative Radio Conference. However, electrical and electronic engineering groups have discussed the subject at symposia and before audiences which have included individuals placed high in the aeronautical scene. There is nothing to restrain the propounders of CNI from championing their progeny, in terms of seeking early recognition of its impact upon the aeronautical communication and navigation community. If the initiative is taken by the proponents of CNI, there will be a broader technological base upon which to build, and through greater understanding, the road to ultimate allocation recognition will be smoothed considerably.

In some quarters there will be a strong urge to "wait" until CNI is better defined and until after experimental data is available to cite as proof of its emerging capabilities. Such a view has much to justify its popularity. The question then becomes, "How do we make an orderly transition from the present day state of affairs and R&D, into the period during which the allocation process will unfold."

The answer to this question is one of timing and degree. Yet, in a sense, the question is easy to equate. Since there has been no substantial preparation for or championing of CNI in respect to the 1971 ITU World Radio Conference, the answer to the question more realistically relates to the preparation for the succeeding ITU World Radio Conference some four or five years hence. This means that after the 1971 Conference has resolved its differences and agreed upon a revision of the ITU Radio Regulations, that publication will become the foundation upon which CNI's future must be based.

Here then, is the cornerstone of future CNI frequency allocation planning. In 1971, 1972 and in no event later than in 1973, all the lower rungs up the ladder to an ITU action will have to be climbed and cleared. Surely the U. S. position for the second ITU Radio Conference of the 1970-80 decade must include a clearly acceptable, supportable, and attractive U. S. proposal for a frequency band to be allocated for CNI.

## SECTION III

## CURRENT FREQUENCY ALLOCATIONS OF INTEREST TO THIS STUDY IN THE 108 MHz to 1660 MHz RANGE

### 3.1 Purpose

The purpose of this section is to inform the reader as to the present use of those portions of the spectrum which must be considered in developing a CNI frequency allocation plan.

### 3.2 108 MHz to 117.95 MHz

This portion of the spectrum accommodates Instrument Low Approach System (ILS) localizers and VHF Omnidirectional Ranges (VOR).

ILS lateral guidance, used to assist the pilot in knowing whether his aircraft is to the right or left of a center line when approaching and landing on an airport runway, is provided by a "localizer" transmitting two discrete antenna patterns on one of 20 channels in the 108 to 112 MHz region. The left hand pattern is modulated at 90 Hertz and the right hand pattern is modulated at 150 Hertz. The aircraft receiver displays the signal by means of the relative positioning of a meter needle which is driven to the right or left of vertical depending upon whether the aircraft is out of position to the right or left. When the landing is proceeding on course, the needle is in the vertical position. The vertical guidance of the ILS system is provided by the "glide slope" transmitter, operated on one of 20 channels from 329 MHz to 335 MHz, and paired with its counterpart lateral guidance channel. (See Section 3.4). The ILS is operated in accordance with ICAO standards, and is used on a worldwide basis. It is not competitive with CNI, and the frequencies allocated for ILS are exclusive, both in the vertical and horizontal channelization required.

The VOR system transmitter radiates a CW signal on one of 20 channels in the 108 to 112 MHz band, (interleaved with localizer frequencies) or on one of 60 similar channels between 112 and 118 MHz. The transmitter antenna pattern is cardoid in shape, and is rotated 30 times per second. A 30 Hertz reference signal is radiated, it being frequency modulated $\pm$ 480 Hertz on a 9960 Hertz subcarrier. The airborne receiver reads bearing as a function of phase difference between the FM signal and the AM 30 Hertz modulation. The total of 80 channels employed by VOR has been given an exclusive allocation in coordination with ILS channelization. The ICAO has supported

the consolidated use of VOR with ICAO Standard Distance Measuring Equipment (DME) beacons. This is discussed further in the paragraph on 960-1215 MHz, (VOR-TAC), below. However, the adoption of a CNI system incorporating a ranging function would require a much larger portion of the spectrum than utilized by VHF VOR alone. Accordingly, CNI developments will not impact the 108-118 MHz frequency band.

### 3.3 118 MHz to 136 MHz

This portion of the spectrum is allocated for Aeronautical Mobile voice communications.

The frequency assignment plan is as follows:

| Frequency (MHz) | Assignment | Channel Spacing (KHz) | Number of ATC Channels | Number of Other Channels |
|---|---|---|---|---|
| 118.0-121.4 | Air Traffic Control | 50 | 69 | 0 |
| 121.5 | Emergency | 100 | 0 | 1 |
| 121.6-123.55 | Airport Utility | 50 | 0 | 40 |
| | Private Aircraft | | | |
| | Flight Test | | | |
| | Flying Schools | | | |
| 123.6-128.8 | Air Traffic Control | 50 | 105 | 0 |
| 128.85-132.0 | Aeronautical enroute communications | 50 | 0 | 64 |
| 132.95-135.95 | Air Traffic Control | 50 | 79 | 0 |
| Channelization Totals (358 in all) | | | 253 | 105 |

Some of the communications equipment employed in this portion of the spectrum is obsolescent. The more recently manufactured airborne equipment in use has been designed with sufficiently good frequency stability and bandwidth characteristics to operate on a 50 KHz spacing basis. However, older and less sophisticated equipment is still in use, which is capable of operating only on a 100 KHz channelization basis. Because of economic considerations, this older type of gear will remain in use for years to come, and the newer equipment will be in use well into the next decade. The majority of non-government airborne transmitters in use can not be switched to as many as 50 selectable channels. Most of those presently in use are capable of being set on only as few as ten channels. Geographical congestion is severe in areas of greatest population density, such as the Northeastern portion of the U. S., and around such cities as Washington, D. C.; Chicago; St. Louis; Dallas; Los Angeles; and San Francisco. The greatest time/usage density occurs in daylight hours, with least congestion of the channels from midnight to 6 a.m. Co-channel and adjacent channel assignments are complicated during unusual propagation anomalies involving ducting and temperature inversions when signals are heard at greater than normal distances. About 9000 ground stations are involved in communications with their airborne counterparts in the civil economy alone. Military aircraft, which must follow FAA flight rules, must be capable of ATC communication with civil agencies, and therefore also use the 118-136 MHz band.

Although there is no presently available basis for making a discrete analysis of the rate of reduction in use of the 118-136 MHz band for aeronautical mobile radio operations due to the advent of CNI in another portion of the radio spectrum, it can be stated with confidence that at least a decade of continued congestion confronts the users of this band, even if a major shift to CNI were to occur. The band certainly is in no position to accommodate a new type of service, such as CNI.

Only 18 MHz of spectrum space is available for the great quantity of uses described above. It should be recognized that quite a bit of the communication in this band relates to aircraft position reporting, which could be reduced by the advent of CNI. If and when the commercial air carriers and the military switch to CNI, in another band, less congestion should then exist here. However, in view of the present saturation of ATC traffic at these frequencies in congested areas, it has been concluded that CNI could not be superimposed upon the present situation, even if the greater bandwidth considerations for CNI were to be disregarded. This requires that we look at the 225 MHz-400 MHz band, the 960 MHz-1215 MHz band and the 1535 MHz-1660 MHz band.

3.4 225 MHz to 400.5 MHz (the so-called Military UHF Band)

The International Allocations for this portion of the spectrum are as follows: (Excerpts from ITU Radio Regulations)

220 MHz-235 MHz

<table>
<tr><th colspan="3">Allocation to Services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td rowspan="2">223-235 MHz<br><br>AERONAUTICAL RADIONAVIGATION<br><br>Fixed<br><br>Mobile<br><br>Footnotes:<br>302<br>303<br>305</td><td>220-225 MHz<br><br>AMATEUR<br>RADIONAVIGATION</td><td></td></tr>
<tr><td>225-235 MHz<br><br>FIXED<br><br>MOBILE</td><td>225-235 MHz<br><br>FIXED<br><br>MOBILE<br><br>AERONAUTICAL RADIONAVIGATION</td></tr>
</table>

Footnotes:

302. In Austria and Switzerland, the band 223 MHz-230 MHz is allocated on a permitted basis to the broadcasting service; the band 230 MHz-235 MHz is allocated to the fixed and mobile services.

303. In Albania, Bulgaria, Hungary, Poland, Roumania, Czechoslovakia and the U.S.S.R., the band 223 MHz 230 MHz is allocated to the broadcasting service. The broadcasting service in these countries shall be introduced so as not to cause harmful interference to the aeronautical radionavigation service and broadcasting stations operating in this band shall be established only in accordance with agreements and associated plans to the concluded at the next European VHF/UHF Broadcasting Conference.

305. In Nigeria, Sierra Leone and Gambia, the band 223 MHz-251 MHz is also allocated to the Broadcasting service.

235 MHz-335.4 MHz

| Allocation of Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| 235-267 MHz | FIXED<br>MOBILE<br>Footnotes 305, 309 | |
| 267-272 MHz | FIXED<br>MOBILE<br>Space (Telemetering) | Footnotes<br>309A, 309B |
| 272-273 MHz | FIXED<br>MOBILE<br>SPACE (Telemetering) | Footnote<br>309A |
| 273 328·6 MHz | FIXED<br>MOBILE<br>Footnote 310 | |
| 328·6-335·4 MHz | AERONAUTICAL<br>RADIONAVIGATION<br>Footnote 310 | Footnote<br>311 |
| 335·4-399·9 MHz | FIXED<br>MOBILE | |
| 399·9-400·5 MHz | RADIONAVIGATION-<br>SATELLITE<br>Footnote 311A | |

Footnotes:

309. The frequency 243 MHz is the frequency in this band for use by survival craft stations and equipment used for survival purposes.

309A. Space stations employing frequencies in the band 267 MHz-273 MHz for telemetering purposes may also transmit tracking signals in the band.

309B. In the band 267 MHz-272 MHz individual administrations may use space telemetering in their countries on a primary basis, subject to the agreement of the administrations concerned and those having services operating in accordance with the Table, which may be affected.

310. Radio astronomy observations on the Deuterium line (322 MHz-329 MHz) are carried out in a number of countries under national arrangements. Administrations should bear in mind the needs of the radio astronomy service in their future planning of this band.

311. Limited to Instrument Landing Systems (glide path).

311A. Stations operating in the fixed and mobile services may continue to use this band until 1 January 1969. This cessation date shall not apply in Bulgaria, Cuba, Greece, Hungary, Iran, Kuwait, Lebanon, Morocco, the United Arab Republic and Yugoslavia where the fixed and mobile services will continue to have equal status with the radionavigation-satellite service.

In the United States, the allocation plan for the 225 MHz-400 MHz portion of the spectrum is as follows:

| | | | |
|---|---|---|---|
| 225 MHz-328.5 MHz | - | GOVERNMENT, INDUSTRIAL (Petroleum, Radio-navigation) SURVIVAL CRAFT AND EQUIPMENT - 243 MHz | (See U. S. Footnotes 17, 98) |
| 328.6 MHz-335.4 MHz | - | GOVERNMENT AND NON-GOVERNMENT AERONAUTICAL RADIONAVIGATION (Glide Path - ILS) | |
| 335.4 MHz-339.9 MHz | - | GOVERNMENT | |
| 399.9 MHz-400.5 MHz | - | RADIONAVIGATION-SATELLITE | (See U. S. Footnote 100) |

The applicable U. S. footnotes to the table above are as follows:

> "U.S. 17. For the radiolocation activities of the petroleum industry only, radiolocation land stations and radiolocation mobile stations making use of SHORAN equipment may be authorized the use of the frequencies 230 MHz, 250 MHz, and 310 MHz at locations within 150 miles of the respective ocean shorelines of Alaska and the contiguous 48 states (including the areas in and about bays and sounds), provided that no harmful interference is caused to stations operating in accordance with the Table of Frequency Allocations and provided that SHORAN operations are coordinated locally in advance with Federal Government authorities making use of frequencies in this band in the same area.
>
> U.S 98. The frequency 243 MHz is the frequency in this band for use by Government and non-Government survival craft stations and equipment used for survival purposes.
>
> U.S. 100. In the Additional Protocol to the Final Acts of the Space EARC, Geneva, 1963, a declaration on behalf of the USA states that the USA cannot accept any obligation to observe the exceptions claimed by Cuba in those footnotes to the Table of Frequency Allocations which were adopted by the EARC and which specifically name Cuba."

A worldwide ITU exclusive allocation is provided for glide slope transmitters operating in the 329 MHz-335 MHz. Aeronautical Radionavigation band. The U. S. National plan contains this allocation also. Vertical guidance relating to instrument low approach landings at airports utilize 20 channels from 329 MHz to 335 MHz, paired one for one with VLF localizer transmitters. Amplitude modulation at 150 Hertz is used to indicate "above course" position. The airborne receiver display, a horizontal needle, is driven up when the aircraft is in the 90 Hertz signal lobe and down when the aircraft is in the 150 Hertz signal lobe. About 550 glide slope transmitters are in use in the U. S.

Utilization of the 225 MHz-400 MHz band by U. S. military forces is substantial. Procurement of military UHF radio equipment became a large dollar capital investment item prior to the Korean war, and has continued unabated since that time, including an accelerated purchase program throughout the last decade. While substantial quantities of vehicular (Land Mobile), land radio relay (Fixed) and naval shipboard (Maritime Mobile) 225 MHz-400 MHz radio equipment have been purchased; in addition to aeronautical mobile radio sets, the following data shows the extent to which the U. S. Air Force has procured avionics equipment which operates in the 225 MHz-400 MHz portion of the spectrum:*

| Equipment Nomenclature | Approximate Quantity in Use |
|---|---|
| AN/ARC-27 | 3392 |
| AN/ARC-34 | 2760 |
| AN/ARC045 | 151 |
| AN/ARC-50/ARQ-23 | 67 |
| AN/ARC-51X/BX | 1225 |
| AN/ARC-70 | 193 |
| AN/ARC-89 | 206 |
| AN/ARC-90 | 293 |
| AN/ARC-109 | 453 + |
| AN/ARC-116 | 79 |
| AN/ARC-133 | 1519 |
| AN/ARC-136 | 286 |
| AN/ARC-147 | 572 |
| AN/ARC-85 | 148 |
| AN/ART-40 | 54 |

Source: Headquarters Oklahoma Air Material Agency, Cost Development Study for CNI, United States Air Force, Air Force Logistics Command, RAD-0-43-1, modified, as of 5 June 1970.

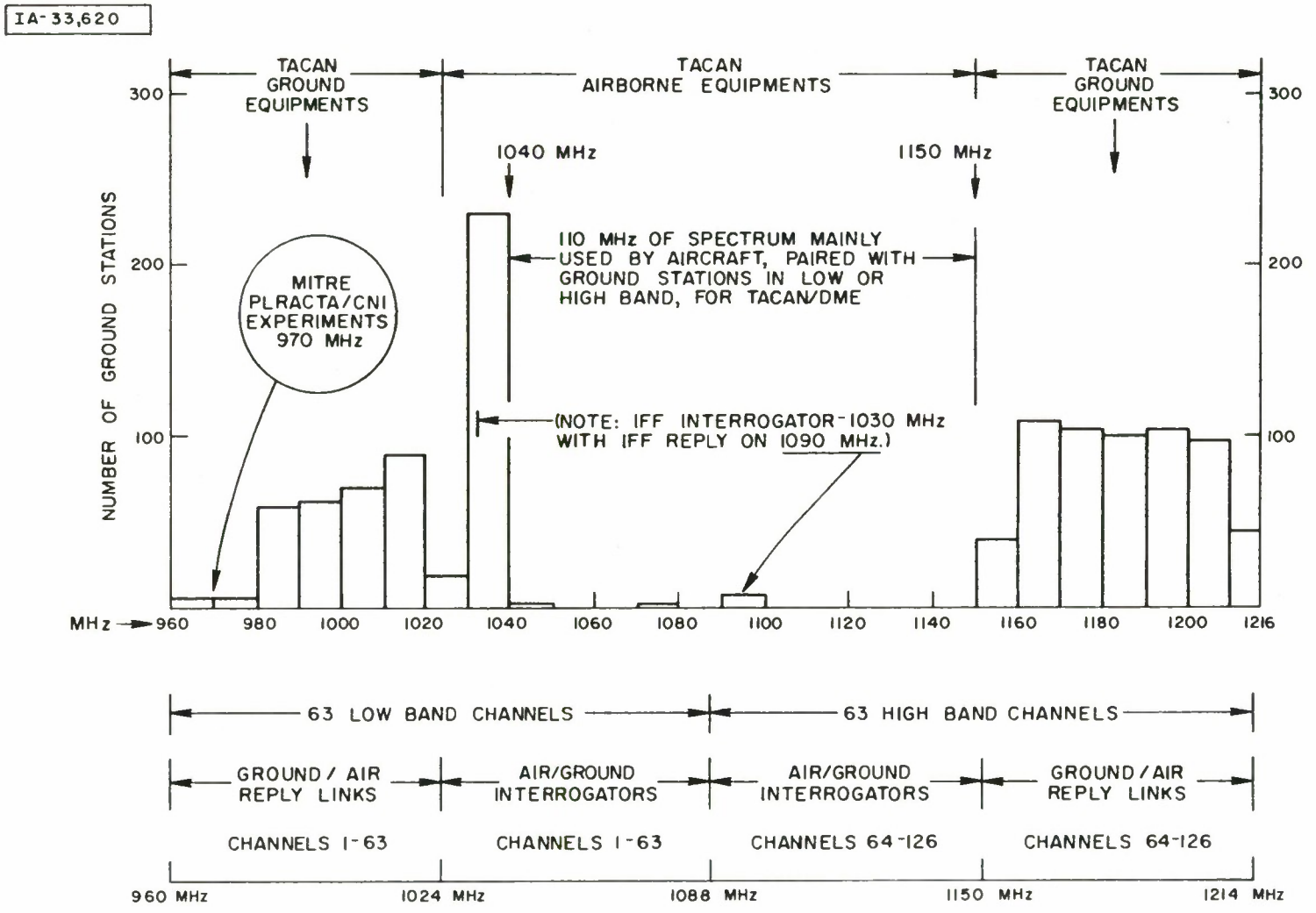



Figure 2. TACAN FREQUENCY PLAN

This avionics equipment represents a very large investment for components, spares, and parts. Repairs, servicing and maintenance expenses are also great, adding millions of dollars to the total life cycle costs. By including the capital investment necessary on the ground, including antennas, power systems and related unique facilities, further capital costs become apparent. The August 1970 FAA Radio Frequency use records showed that over 1600 ground radio stations, exclusive of ILS glide slope transmitters, were operated in the U. S. in the 225 MHz-400 MHz portion of the spectrum. Much of this involved military functions directly related to FAA activities.

## 3.5 960 MHz to 1215 MHz

The ITU has reserved the 960 MHz-1215 MHz band "on a worldwide basis exclusively for the use and development of airborne electronic aids to navigation and any directly associated ground-based facilities". (Footnote #341 to the ITU Allocation Table). No nation has taken exception to this regulation.

Within this portion of the spectrum, a line-of-sight short distance rho-theta air navigation system is operated to provide bearing and distance information referenced to selected ground stations. It is called TACAN, which provides short-range navigational (line of sight) information to military aircraft carrying suitable equipment. Civil aircraft make use of TACAN to obtain distance, "rho" information, normally in conjunction with VOR ground stations co-located with TACAN ground stations. The VOR provides the "theta" information with an accuracy of $\pm 1.9$ degrees 95% of the time. However, airborne components may contribute up to 2.6% of additional errors in directional indication. DME provides distance (rho) information, with an accuracy of $\pm 0.5$ Nautical Mile or 3% of the slant range (whichever is greater) 95% of the time. TACAN is thus able to perform all of the functions of VOR plus DME, but with no VLF (VOR) component, but in such a mode supports military aircraft to an extent beyond the support provided to civil aircraft.

The DME used with TACAN employs the following frequency plan: (See Figure 2).

| | | |
|---|---|---|
| AIRBORNE INTERROGATORS | - | 1025 MHz to 1150 MHz (126 channels) |
| GROUND TRANSPONDERS | - | 961 MHz to 1024 MHz (63 channels)<br>1151 MHz to 1213 MHz (63 channels) |

The TACAN military IFF employs a 400 pulse per minute interrogator on 1030 MHz in conjunction with a reply transponder at 1090 MHz. Both ground and airborne stations use these two frequencies.

Each of the 126 TACAN channels consist of a pair of frequencies separated by 63 MHz. One frequency is used to interrogate a particular ground station which replies on the paired frequency. Therefore, a total of 252 frequencies, separated by 1 MHz are required. The IFF interrogate and reply channels, which are paired on 1030 and 1090 MHz, (TACAN channels 6 and 66) require up to as much as 10 MHz of bandwidth to avoid interference to the adjacent TACAN channels, which results in few TACAN assignments on the nearby channels. Only six stations in the CONUS have been assigned TACAN channels 1 through 18, and twelve stations have been assigned channels 60 through 69. (No stations are assigned channels 2, 3, 4, 6, 7, 8, 9, 10, 63 and 67). Every other TACAN channel pair is assigned to several stations, geographically separated to avoid interference.

Based upon a study of the wide geographical separation plan for the use of TACAN frequencies, it became clear that the 961.5 MHz-979.5 MHz portion of the "TACAN" band would be reasonably free from interference in the area of Hanscom Air Force Base, Massachusetts and in the area of Eglin Air Force Base, Florida. Accordingly, a temporary authorization permits conducting PLRACTA/CNI experiments at 969 MHz to 970 MHz, strictly on a non-interference basis to operational TACAN users at these locations.

The TACAN band is not heavily loaded. Even if all channels were used for TACAN/IFF purposes to the normal extent by 1000 aircraft within and over a given single highly congested 300 mile line-of-sight area, the use duty cycle would be below 2%. It is uncommon in actual TACAN operations to find 0.1% utilization of the band, except at 1030 and 1090 MHz, where all IFF transponding is concentrated. The low duty cycle characteristic of TACAN lends validity to the proposition of consolidating operations on fewer channels than are available at present. The portion of the band thus released could be used by CNI, for example. If such an arrangement were to be worked out with the regulatory agencies, both types of use would then enjoy <u>exclusive</u> assignments, which would satisfy the traditional "Safety of Life" requirement that all Aeronautical Radionavigation Systems must be accorded <u>Exclusive</u> spectrum use rights.

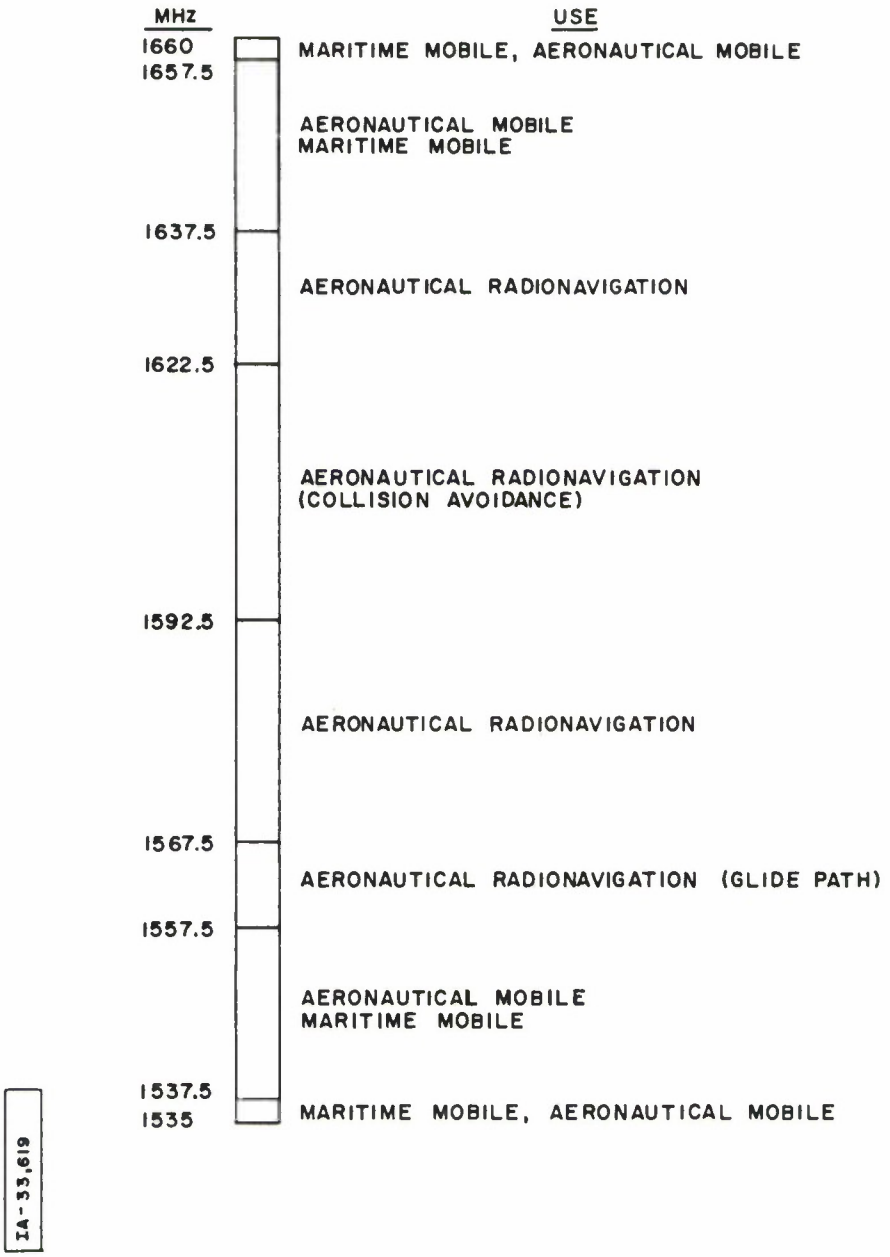


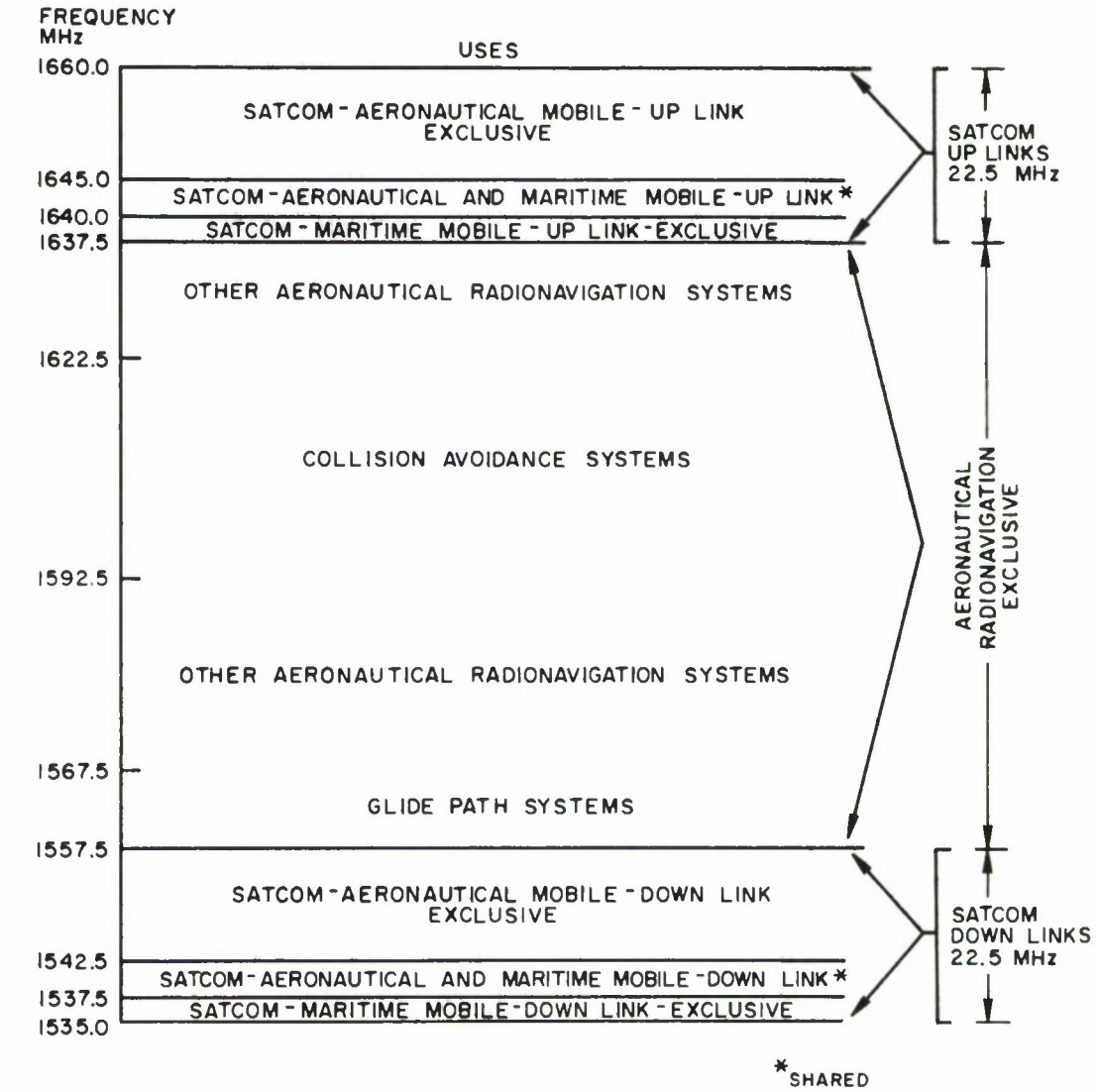

Figure 3. U.S. ALLOCATION OF 1535 MHz-1660 MHz BAND AS DIRECTED IN FCC ORDER, DOCKET 18550, 13 FEBRUARY 1970

## 3.6 1535/40 MHz-1660 MHz

This portion of the spectrum was set aside for aeronautical navigation purposes as a result of action taken at the 1947 ITU World Radio Conference at Atlantic City, New Jersey. While that action was intended to facilitate the development of future aeronautical (safety of life) navigational aids and air traffic control systems, the band was little used for nearly two decades. It saw use mainly only as a frequency band for radar altimeters until after the 1959 ITU Radio Conference, which reaffirmed the allocation from 1540 MHz to 1660 MHz for Aeronautical Radionavigation. From 1967 to 1970 there was pressure from the U. S. air carriers (ATA and ARINC) to change FCC rules to provide for collision avoidance systems and glide path radio systems in the band. On 13 February 1970, the FCC issued a new U. S. allocation plan, illustrated in Figure 3. Note that this figure shows the 1535 MHz-1540 MHz Space Telemetry band being incorporated with the 1540 MHz-1660 MHz allocation plan into a 1535 MHz-1660 MHz band.

During 1970 the FCC and the Office of Telecommunications Policy, (OPT) of the Executive Offices of the President have conducted an inquiry into the future uses of this band, leading toward the U. S. position to be taken at the 1971 ITU World Administrative Radio Conference to be held in Geneva in June and July 1971. Coordination within the government and within industry has been thorough. The U. S. national Executive Committee of the CCIR has also studied the problem. The results of this substantial effort are discussed in Part IV of this report.

The 1535 MHz-1660 MHz band is now set aside for newly developing collision avoidance, glide path and radar altimeter systems. About 7000 pulsed radar altimeters are operating in the 1600 MHz-1660 MHz portion of the band, of which nearly three fourths are carried in military aircraft. Collision avoidance systems use frequencies between 1592.5 MHz and 1622.5 MHz. Glide path systems use frequencies from 1557.5 MHz to 1567.5 MHz. The segments 1535-1557.5 MHz and 1567.5-1592.5 MHz are little used at present. However, the 13 February 1970 FCC order cited above stated that U. S. national frequency planning is to locate all radar altimeters in the 4200-4400 MHz band. Thus, in time the radar altimeter use of this band will have diminished. No cut off date exists for exclusion of present users, and it is likely that attrition will be slow, if and when this becomes desirable. There is no use of this band by communication, navigation or identification systems at present.




IA-33,621

Figure 4. DECEMBER 1970 PROPOSALS OF THE UNITED STATES FOR THE ITU WORLD ADMINISTRATIVE RADIO CONFERENCE FOR SPACE TELECOMMUNICATIONS GENEVA SWITZERLAND 1971, 1535-1660 MHz, (SUBJECT TO CHANGE DUE TO NEGOTIATIONS).

The U. S. Proposal for allocating a portion of this band for Space/Aeronautical/Maritime Mobile uses has caused a general reconsideration of its planned future use. Both civil aviation and maritime interests are seeking communications support from satellite systems. They also are showing interest in navigation satellites. It is hard to justify separate systems for each of these uses, providing it can be shown that they can be combined or integrated. Also, there are some differences of opinion as to whether or not aviation and maritime systems need to share the same satellites for these somewhat common services. The simplest solution to this last question has been to propose using some of the bandwidth of the satellite for aeronautical purposes exclusively, another segment for maritime purposes exclusively with the two sharing a third segment. The 1971 U. S. position on this matter, as illustrated in Figure 4, is to allocate 22.5 MHz at each end of the 1535 MHz-1660 MHz band for satellite links in support of aeronautical and maritime communication uses. The U. S. position does not spell out how the middle 80 MHz portion of the proposed band might be used, beyond simply specifying its allocation for "Aeronautical Radio-navigation". This subject is discussed further in Section IV.

SECTION IV

# U. S. NATIONAL POLICY, PLANS AND PROPOSALS RELATING TO AERONAUTICAL RADIONAVIGATION AND AERONAUTICAL MOBILE SERVICES

## 4.1 General

Aeronautical aids to navigation may be divided into three major categories associated with long distance, shorter of line-of-sight distance, and terminal area operations. The same general division of categories can be applied to the radio communication, navigation, and identification facilities which are involved with air flight operations, whether military or civil. CNI would concentrate upon the line-of-sight case, except when satellites are included in the system.

Not only are there a proliferation of types and varieties of radio equipments involved in the present systems in use to support the above mentioned functions, but also there has been a serious waste of electromagnetic spectrum space as these systems have evolved. Added to this congestion has been the expansion of and extension of purely military means, even though in many cases flight operations occur in regions of the world which neither civil or military users could claim exclusive rights of access. While certain unique requirements accrue to the military, such as protection from willful interference and closer constraints based upon faster aircraft, it must be recognized that the optimum air traffic control and radio navigation system will be one which can serve all users, and in so doing, eliminate any redundancy in ground or airborne equipment, as well as any proliferation of claims for frequency allocations.

## 4.2 Department of Transportation National Plan for Navigation

With the establishment of the Department of Transportation (DOT) in 1967, a natural focal point for civil air navigation planning and coordination became a reality. Accordingly, the DOT has published a "National Plan for Navigation" the first edition having been promulgated on 5 June 1970. This plan is intended to provide a basis for the development of future navigation systems, including long and short distance types. The DOT plan embraces the requirements for long distance civil air navigation promulgated by the International Civil Aviation Organization (ICAO) on 9 November 1965, as follows:

"Coverage. The systems should be capable of providing service over all the used airspace of the world, regardless of the time, weather, altitude, terrain, and propagation characteristics.

Reliability/Integrity. The overall integrity of the system, including the presentation of information in the cockpit, shall be as near 100% as is achievable and to the extent feasible should provide flight deck warnings in the event of failure, malfunction, or interruption.

Ambiguity. The navigational information provided by the system must be free from unresolved ambiguties of operational significance.

Capacity. Any station-referenced component of the navigational system shall be capable of providing navigational information simultaneously to all aircraft which require access to it.

Presentation. The system must have the capability of providing the pilot with a continuously available indication of present position in operationally meaningful terms and with information enabling him to follow the designated track with the accuracy required and to estimate further progress of the flight. A lag of five seconds is acceptable of presentation of position.

Compatibility. The long distance navigation system must, from an operational viewpoint, permit smooth integration with navigational requirements applicable in other phases of flight.

Accuracy. The system must provide the navigational capability needed in specific areas and permit the application of the horizontal separation minima necessary, so as to accommodate present and forecast traffic."

From the above, it can be seen that the requirements for long distance air navigation tend to blend with short distance requirements to some extent. The DOT plan makes the following statement:

"Short Distance Air Navigation Requirements. The need for a short distance navigation service in the continental U. S. is intimately associated with the operation of the entire Air Traffic Control system. Such service is currently provided by the use of approximately 800 VOR/DME installations. These facilities provide a system of air navigation routes throughout the U. S., interconnecting all major cities where commercial traffic flows.

"System accuracy now permits the establishing of a route width of eight miles in the low altitude structure, and a greater width at higher altitudes and to longer ranges based on the angular accuracy of the VOR.

"The need for an area navigation capability free of fixed routes requires the upgrading of VOR/DME signal accuracy and quality at some locations. Detailed analysis of VOR/DME capabilities associated with these plans for the expansion and modernization of the Air Traffic Control system have been undertaken in depth and there is no need to consider such short distance aids in this plan. Since there are no areas of conflict with regard to new development for either marine or military use that require resolution, it is not considered necessary to provide either an operational or a development plan in this area."

The DOT National Plan for Navigation first mentions the integration of CNI type services in its Research and Development Program description, but mainly with respect to the utilization of satellite technologies. A multi-functional satellite development is visualized, which will address navigation, communications and data acquisition on an integrated basis. It is stated that the FAA and U. S. Coast Guard will participate with NASA and the Department of Defense to develop the necessary technology and establish its application to air and marine navigation, surveillance and communication. The plan states, "The use of satellites for navigation will be dependent on the advances made in their use for communication and surveillance. Satellite navigation will be evaluated for civil and marine operations on a comparative basis with OMEGA when the technology and system status have advanced to a point where meaningful comparisons can be made". (OMEGA is a VLF CW phase comparison byperbolic navigation system. System accuracy is potentially 2 to 4 nautical miles, 95% of the time.)

## 4.3 Proposals of the United States for the ITU World Administrative Radio Conference for Space Telecommunications, Geneva, 1971

Over the past several decades it has become necessary for the ITU to meet at intervals of several years to update its Radio Regulations in accordance with the advancements in technology and other factors which have caused substantially increased demands for frequency allocations by a number of users or "services". The United States has been a leader in improvement and progressive refinement of the Regulations. The means used to achieve this end has been study the problems thoroughly in such U. S. forums as the Institute of Electrical and Electronics Engineers (IEEE), the Joint Technical Advisory Committee of the National Electronics Association (JTAC), the U. S. Study Groups of the International Consulting Committee on Radio (CCIR), and within such governmental agencies, departments and bureaus as the DoD, FAA, NASA, the Interdepartment Radio Advisory Committee (IRAC), the FCC and the Office of Telecommunications Policy (OTP) of the Executive Offices of the President. At the end of this process, the Department of State publishes the consolidated views of the above mentioned contributors as a U. S. "Position Paper". Such a process was followed with respect to the forthcoming 1971 ITU World Administration Radio Conference, and because of the formulation of such a document, we have a very firm and current basis upon which to base up to the minute CNI frequency planning. To go contrary to the official U. S. position would be to invite the opposition of the very influential and decisive groups who must eventually be asked to approve radio frequency allocation applications for CNI.

The U. S. Position paper treats with two areas of interest to CNI systems planners, namely communications and aeronautical radio navigation. Accordingly, the following quotations from the "U. S. Proposals" are cited:

> "The problems of radiodetermination and air traffic control will become far more urgent when supersonic aircraft come into regular service. For surface craft, there still is no single system that can provide a ship's captain with an accurate position fix wherever and whenever it is required. Space techniques offer the potential for an electronic system of radiodetermination and traffic control that will meet aeronautical and maritime requirements on a universal basis."

"Communication-Satellite Service. The frequency allocations made at the Space EARC,* Geneva, 1963, for the communication-satellite service were, with minor exception, shared with terrestrial fixed and mobile services. This required certain constraints in respect of earth stations and limitations on the power flux density of space station signals at the surface of the earth, as well as limitations to terrestrial stations, to preclude harmful mutual interference. Although satisfactory sharing between these services has been demonstrated for international service, certain domestic applications of communication satellites in the presently allocated bands may not be practicable due to the number and location of earth terminals contemplated. To have made exclusive allocation provisions for the communication-satellite service at the Space EARC, 1963, would have dictated either extremely narrow frequency bands in the range 1 - 10 GHz because of existing terrestrial services, or the allocation of bands above 10 GHz. The former course of action would have resulted in reduced system capacity, which would not have been economical considering the high cost of developing communication satellite systems, and inadequate provision for future growth. The latter course of action would have delayed the early introduction of practical systems because of technological and physical limitations.

"Radionavigation-Satellite Service. The Space EARC, 1963, allocated three frequency bands for radionavigation satellites, 149.9-150.05 MHz, 399.9-400.05 MHz and 14.3-14.4 GHz. A doppler range-rate radionavigation-satellite system is currently operational in the two lower bands. Advanced system development and equipment design, including new ranging techniques to improve navigational accuracy and a decrease in the time required for obtaining navigational fixes, are currently under study. However, no proposal with respect to additional frequency allocations for the radionavigation-satellite service is being made at this time.

*EARC - ITU Extraordinary Administrative Radio Conference (1963).

"Aeronautical and Maritime. The provisions made at the Space EARC, 1963, for the use of space techniques in the aeronautical mobile (R) service need to be augmented to provide for possible joint system use by the aeronautical and maritime mobile services. Similar provisions need to be established for maritime functions. Therefore, changes are being proposed which provide for the use of space techniques in portions of VHF and UHF bands. Proposals are also made for allocations and provisions for using space techniques to support projected aeronautical and maritime needs above 40 GHZ.

"At the past conferences, no provisions have been made for the use of space techniques in the maritime mobile service. However, the need for such provision was recognized by the recent WARC (1967) for maritime matters.* Recommendation No. MAR 3 of that Conference invites Administrations to study the possible ways of accommodating maritime requirements, which cannot be met by existing frequency resources. These requirements include the need for circuits of high reliability, service in areas where existing services are neither adequate nor economical to provide, and for data transmission, such as those intended for direct introduction into computers. Therefore, proposals are included which provide for the use of space techniques in portions of the band 156-174 MHz. Tests have been in progress for several years in the USA with Applications Technology Satellites (ATS) to develop conditions for operation of maritime mobile communications and to develop operating experience. These proposals offer early use of this technique for the more urgent maritime requirements.

"In order to provide for the expansion of either the aeronautical or maritime use of space techniques and to provide for the possibility that joint aeronautical and maritime use of space techniques may prove desirable for both communications and radiodetermination, it is proposed to reallocate the bands 1535 MHz-1540 MHz and 1540 MHz-1660 MHz. It is then proposed to

*WARC - ITU World Administrative Radio Conference (1967).

suballocate 22.5 MHz on each end of the combined band 1535 MHz-1660 MHz to provide 5 MHz of spectrum exclusively for maritime use (2.5 MHz up and 2.5 MHz down) and 30 MHz of spectrum for exclusive aeronautical mobile (R) use (15 MHz up and 15 MHz down). The remaining 10 MHz would be allocated co-equally to aeronautical mobile (R) and maritime to accommodate any joint systems which may be developed. Operation of joint systems would be facilitated by the nature of the suballocation which would permit uniform translation in the space segment.

The following specific recommendations for wording of the revised ITY Radio Regulations were contained in the U. S. Proposals:

| "1535 MHz-1660 MHz | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| 1535-1537.5 MHz | ~~SPACE-(Telemetering)~~<br>MARITIME MOBILE<br>Footnotes: ~~350A-351~~<br>352 352C 352E | |
| 1537.5-1532.5 MHz | ~~SPACE-(Telemetering)~~<br>~~AERONAUTICAL-RADIONAVIGATION~~<br>AERONAUTICAL MOBILE (R)<br>MARITIME MOBILE<br>Footnotes: 350A 351 352<br>352A 352B 352C 352D 352F | |
| 1542.5-1557.5 MHz | ~~AERONAUTICAL-RADIONAVIGATION~~<br>AERONAUTICAL MOBILE (R)<br>Footnotes: ~~351~~ 352 ~~352A~~<br>~~352B~~ 352D 352G | |
| 1557.5-1637.5 MHz | AERONAUTICAL RADIONAVIGATION<br>Footnotes: ~~351~~ 352 352A<br>352B 352D | |

| Region 1 | Region 2 | Region 3 |
|---|---|---|
| 1637.5-1640 MHz | ~~AERONAUTICAL-RADIONAVIGATION~~<br>MARITIME MOBILE<br>Footnotes: 352 ~~352A-352B~~<br>352D 352H | |
| 1640-1645 MHz | ~~AERONAUTICAL-RADIONAVIGATION~~<br>AERONAUTICAL MOBILE (R)<br>MARITIME MOBILE<br>Footnotes: 352 ~~352A-352B~~<br>352D 352I | |
| 1645-1660 MHz | ~~AERONAUTICAL-RADIONAVIGATION~~<br>AERONAUTICAL MOBILE (R)<br>Footnotes: 352 ~~352A-352B~~<br>352D 352J | |

Footnotes:

MOD 352A. The bands ~~1540-1660 Mc/s~~ 1557.5-1637.5 MHz, 4200-4400 ~~Mc/s~~ MHz, 5000-5250 ~~Mc/s~~ MHz and 15.4-15.7 ~~Gc/s~~ GHz are reserved, on a world-wide basis, for the use and development of airborne electronic aids to air navigation and any directly associated ground-based or satellite-borne facilities.

MOD 352B. The bands ~~1540-1660 Mc/s~~ 1557.5-1637.5 MHz, 5000-~~5250 Mc/s~~ MHz and 15.4-15.7 ~~Gc/s~~ GHz are also allocated to the aeronautical mobile (R) service for the use and development of systems using space communication techniques. Such use and development is subject to agreement and coordination ~~between~~ among administrations concerned and those having services operating in accordance with the Table, which may be affected.

ADD 352E. Limited to transmissions from satellite-borne stations to stations in the maritime mobile service for communication and/or radiodetermination purposes.

ADD 352F. Limited to transmissions from satellite-borne stations to stations in the aeronautical mobile (R) and maritime mobile services for communications and/or radiodetermination purposes. Transmissions from terrestrial aeronautical stations directly to aircraft stations in the aeronautical mobile (R) service are also permitted when such aeronautical stations are utilized to augment and/or interface with the satellite-to-aircraft links.

ADD 352G. Limited to transmissions from satellite-borne stations to stations in the aeronautical mobile (R) service for communications and/or radiodetermination purposes. Transmissions from terrestrial aeronautical stations directly to aircraft stations in the aeronautical mobile (R) service are also permitted when such aeronautical stations are utilized to augment and/or interface with the satellite-to-aircraft links.

ADD 352H. Limited to transmissions from stations in the maritime mobile service to satellite-borne stations for communication and/or radiodetermination purposes.

ADD 352I. Limited to transmissions from stations in the aeronautical mobile (R) and maritime mobile services to satellite-borne stations for communication and/or radiodetermination purposes. Transmissions from aircraft stations in the aeronautical mobile (R) service directly to terrestrial aeronautical stations when such aeronautical stations are utilized to augment and/or interface with the aircraft-to-satellite links.

ADD 352J. Limited to transmissions from stations in the aeronautical mobile (R) service to satellite-borne stations for communication and/or radiodetermination purposes. Transmissions from aircraft stations in the aeronautical stations are also permitted when such aeronautical stations are utilized to augment and/or interface with the aircraft-to-satellite links.

REASON: To designate bands specifically for the development and operational use of systems employing space techniques to meet the communication and radiodetermination requirements of the aeronautical and maritime communities. The overall distribution of bands between the aeronautical mobile (R) and maritime mobile services between 1535 and 1660 MHz is such as to permit the development of either separate or joint systems, inasmuch as provision has been made for a common translation frequency between the "up and "down" bands."

The World Administrative Radio Conference for Space Telecommunications will meet in Geneva in June and July 1971, and will consider all of the U. S. proposals cited above. After the conference has published its findings, the participating nations will ratify the Protocol (published findings) thereof, which will thus evolve into the next published edition of the ITU Radio Regulations, probably in 1972. When published, the Radio Regulations will be binding, until further revised later in the decade.

## 4.4 Statement of U. S. Government Policy on Satellite Telecommunications for Internation Civil Aviation Operations, 7 January 1971.

On 7 January 1971, Dr. Clay T. Whitehead, Director of Telecommunications Policy (OTP), Executive Office of the President, announced the U. S. National policy providing the framework for development of aeronautical satellite programs in the U. S. during the 1970 decade. This policy was established after lengthly study and coordination. It will be noted that it complements the DOT National Policy for Navigation, and the U. S. Position for the 1971 ITU World Administrative Radio Conference. The relevant portions of the Statement are quoted as follows: (See next page).

"STATEMENT OF GOVERNMENT POLICY
ON
SATELLITE TELECOMMUNICATIONS
FOR
INTERNATIONAL CIVIL AVIATION OPERATIONS, 7 JANUARY 1971

The rapid increase in aircraft traffic densities, the introduction of larger passenger aircraft on international overseas routes, and the limitations in existing communications channels make it increasingly clear that improved telecommunications will be required for air traffic control to speed the flow of traffic and to assure aircraft safety.

The Federal Aviation Administration (FAA) has defined and stated the general quantity and quality of the telecommunication services that will be needed to support expected future air traffic control operations. Specific requirements have been established for voice and data communications and for automatic reporting of aircraft position information over both the Atlantic and Pacific Oceans in the early 1970's. The FAA also anticipates an operational requirement for independent surveillance in the later 1970's or early 1980's.

It is clear that the provision of these services is in the public and national interest. There is broad consensus in both government and the private sector that satellites offer technically and economically the most practicable method to meet the requirements in a reliable way. This policy statement is provided to establish guidelines that will permit the effective, efficient, and orderly progress of a national program to provide the needed services.

OBJECTIVES

The objectives of this policy are to:

1) Assure the safety, efficiency, and economic viability of international civil aviation.

2) Promote the timely and useful application of technological advances to assure adequate, reliable, and economic telecommunications for air traffic control, operational control, and search and rescue.

3) Assure that program institutional arrangements are responsive to the requirements of the users, compatible with the evolving National Aviation System, and consistent with the foreign policy objectives and commitments of the United States.

4) Encourage international cooperation in research, development, and applications programs within an institutional framework which assures effective utilization of resources.

5) Facilitate early deployment of advanced applications such as independent surveillance and navigation.

6) Minimize duplication of Federal facilities and programs and encourage the use of facilities available from the private sector.

TECHNICAL AND OPERATIONAL REQUIREMENTS

Pre-operational use and evaluation of voice communications should be implemented in the Pacific in 1973 and Atlantic in 1975. Pre-operational deployment of data link communications and automatic reporting of aircraft position will be promoted in the Atlantic and Pacific in 1975. Feasibility demonstration of independent surveillance in an Air Traffic Control environment will be promoted in the Pacific in 1973, with subsequent transition to a pre-operational evaluation in the Pacific and Atlantic in the post-1975 time period.

It is the Government's policy to promote use of the UHF frequency band near 1600 MHz in the operational system. This will alleviate serious spectrum congestion at VHF frequencies, permit early achievement of the benefits of independent surveillance, and accords with foreign Administration preferences. Use of UHF rather than VHF in the pre-operational system will avoid economic, technical, and operational difficulties--both domestic and international--which would result from a later transition from a VHF system to the UHF band. In support of this objective, the Government will utilize UHF for air traffic control purposes in the pre-operational system.

To assure orderly growth and efficient deployment of aeronautical satellite systems, implementation of initial systems should be compatible with long-term objectives. Communications in the wide sense and reliable knowledge of aircraft position will continue to be essential parameters in the air traffic control system. The Federal Aviation Administration's National Aviation System Science

Advisory Committee suggest that the long-term role of communications in air traffic control will involve automatic data collection, data processing, control, and display utilizing digital data links and digital processing techniques. Pre-operational satellite communication and surveillance systems in the Pacific and Atlantic oceanic areas should be designed and phased in coordination with the domestic plan to assure interoperability between the international and domestic systems with the consequent economics and operational advantages."

## SECTION V

## ADDITIONAL POINTS TO BE CONSIDERED IN CNI FREQUENCY ALLOCATION PLANNING

### 5.1 Military-Civil Aviation Economic and "Safety of Life" Considerations.

It appears that the United States Military establishment is the most likely proponent to be given the fiscal resources necessary to carry through a comprehensive CNI research and development program. At the present time, the civil air carriers of the world are experiencing reduced revenues and are either operating at a loss or at modest profit levels. Much government subsidization of their operations is now necessary. It is reasonable to conclude that the introduction of the first generation system to consolidate aeronautical radionavigation, communication and identification functions will emerge as a result of the work now being prosecuted by the United States Military Departments. Insofar as space satellites used for CNI are concerned, the NASA and the FAA will join into any general community of interests, but on the basis of financial factors, the Military Services can be expected to take a substantial development role. The impact of this judgment might be to suggest that those portions of the spectrum which have traditionally been set aside by IRAC/FCC agreement for sole U. S. government use would be most attractive as candidate CNI bands. The problem with this judgment is that it tends to complicate civil application of CNI. After the military had developed CNI experimentally to fit in a specific "government" band to which a variety of military fixed and mobile users have access, it might have to be made operational in another band into which civil aviation operations would be accommodated without having to share rights of access with non-navigational types of uses.

The 225 MHz-400 MHz band has been reserved by the U. S. military services for a conglomeration of purposes. The U. S. Joint Chiefs of Staff have for over 25 years followed the practice of relating it to many types of Fixed and Mobile uses, including but not limited to Aeronautical Mobile. A very heavy investment exists in currently used military radio equipment capable of operating only in this band. There are widely held opinions to the effect that in a general war, severe degradation of performance would result whenever a large complement of the rightful claimants to this band were required to use their radio equipments in a single contiguous geographical region. It is not considered reasonable to deny the rights of access of the current users of this band on the basis of allocating it for exclusive CNI use. Yet, without such a provision, there is great risk to harmful interference to CNI, in the 225 MHz-400 MHz band.

The current worldwide ITU frequency allocation regulations specify that Fixed and Mobile services are to use this band. In a few countries, there are also broadcast stations using the band. Collectively there are many reasons not to inject CNI into such a conglomeration of potential interferers. Conversely, CNI cannot be regarded as a new user to be welcomed into their midst, since additional radiated radio energy would not be desirable where congestion is already a headache to the present users.

This highlights the substantially important "safety of life" aspect of Aeronautical Radionavigation frequency allocations. They traditionally have enjoyed exclusive rights with no sharing with any other type of "service" such as Fixed, Mobile, or Radiolocation, for example. Such a position has been justified on the basis that commercial air passenger carriers cannot be called upon to depend upon navigational aids which could be degraded by any type of interference.

It can be expected that both national and international tables used for CNI purposes in the future will be closely patterned after the wording of ITU Frequency Allocation Table footnotes 341 and 352B. Hypothetically,

> "The band XXX MHz to XXX MHz is reserved (on a worldwide basis) for the exclusive use and development of airborne electronic aids to navigation communication and identification systems, and associated ground based facilities."

The effect of this requirement will be to polarize the attitude of the civil aviation groups away from the 225 MHz-400 MHz band and towards the higher bands where Aeronautical Radionavigation has been allocated exclusive rights.

## 5.2 Bands into which CNI Could be Given Exclusive Rights of Access

### 5.2.1 960 MHz 1215 MHz

This band has many features which recommend that it be considered for CNI:

- It is capable of accommodating a large number of wideband (up to 10 MHz) channels.
- It is currently allocated to the Aeronautical Radionavigation on an ITU Worldwide exclusive basis.

- It is quite possible that major components of existing TACAN and VOR/TAC radio equipment packages can be adapted to use in a transitional CNI system, thus reducing new investment requirements.

- Two types of evolutionary transitions from TACAN to CNI are possible. The first would be accomplished by allowing CNI to be given exclusive rights to selected TACAN interrogator and response channels, and limiting TACAN to using the remainder. The second would be to authorize co-use of the total band, provided there were no electromagnetic compatibility problem.

- The density of use of the band is very low, and the TACAN receiver is designed to work satisfactory in the face of up to 6000 random interfering pulses per second, which exceeds the level to be reached by CNI by as much as 5 or 6 times.*

It should be noted that the United States has not formally proposed to restructure the TACAN band in the manner that has been proposed for the 1535 MHz-1660 MHz band. The TACAN channelization plan, as shown in Figure 2, mitigates against this. Nevertheless, if we can assume that because of the light loading of the TACAN band by TACAN and VOR/TAC users, some compression of the spectrum space allocated for this purpose could be accommodated. By re-engineering the TACAN band frequency assignment plan, so as to require perhaps two-thirds of the present 252 channels, about seventy-five megahertz could be broken loose for exclusive use in the development of CNI. This might be referred to as the "First Generation CNI", in which only line-of-sight navigation would be applied, as is the case at present.

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Note:

(A CNI system being developed by the Avionics Division of ITT of Nutley, New Jersey, envisions a level of only 750 random pulses per second per TACAN channel, from a CNI system covering an area 200 miles on a side including 1000 military aircraft, 1000 civil aircraft, 20 command data link channels, 20 stationkeeping operations, 20 navigational beacons, 10 ATC centers, and 10 surveillance centers).

5.2.2 1535 MHz-1660 MHz.

This band can be said to be the least heavily loaded of the three bands under serious consideration. It is already allocated on a worldwide exclusive basis to Aeronautical Radionavigation. Yet, two of the uses to which it is now being put are employing pulsed signals, namely radar altimeters and collision avoidance airborne radars. Most of the equipment for these two types of systems are operated in the 1590 MHz to 1640 MHz portion of the band. There is little or no real emergence of glide path systems at the portion of the band considered for their use, 1557.5 MHz to 1567.5 MHz.

Effective in April 1970, the FCC discontinued issuing "type approvals" for any new radar altimeters in this band. The FCC in their decision stated that they would approve new type requests for radar altimeters in the 4200 MHz to 4400 MHz portion of the spectrum.

Realistically, this leaves only the question of the future of airborne collision avoidance radar systems which are being developed operate in the 1600 MHz region. If this development gets a strong foothold, a part of the center portion of the band could be dominated by a use which may be inimical to CNI.

The opportunity for the U. S. aeronautical interest, both civil and military, to stake out a far reaching claim to a totally integrated, exclusive CNI band is fleeting. It would be best to prosecute a comprehensive CNI frequency allocation "drive" in 1971 and 1972. Now this effort could avail itself of strong support, such as from the U. S. position for the 1971 ITU World Conference, and the position taken by Dr. Clay Whitehead, the Director of Telecommunications Policy in the Executive Office of the President, supporting aeronautical mobile space satellite relay development for the 1535 MHz-1660 MHz band.

## SECTION VI

## CONCLUSIONS AND RECOMMENDATIONS

### 6.1 Conclusions

It is concluded that:

6.1.1 The introduction of, and the transition into the use of CNI will be an evolutionary process.

6.1.2 It appears attractive from a spectrum allocation point of view to develop a frequency plan for CNI oriented toward a band that reasonably may be allocated for worldwide exclusive use, with no sharing with Fixed, Mobile, Broadcasting, or other basic radio services, either civil or military.

6.1.3 The 960 MHz-1215 MHz band, which now is exclusively allocated to the Aeronautical Radionavigation service, is the most suitable portion of the spectrum to use for the introductory phase of CNI. The present use of this band by TACAN and VOR-TAC is characterized by a low duty cycle of transmissions. For initial, developmental purposes, approximately 75 MHz of the band could be set aside for exclusive CNI use by re-engineering the present channel assignments for TACAN and VOR-TAC into the remaining 170 MHz of the band.

6.1.4 During the introductory phase of CNI, a very carefully developed Electromagnetic Compatibility plan will be required. The purpose of this plan will be to insure that no harmful interference is allowed to occur to operational users of TACAN, VOR-TAC and CNI, since they will be "safety of life" services.

6.1.5 After CNI becomes operationally proven by U. S. Military Aerospace forces, it will be considered for use by the civil aerospace community. This should coincide with the introduction of the second generation CNI system.

6.1.6 While CNI may initially be developed without the use of space satellite repeaters, all frequency allocation planning for CNI should provide for an orderly transition into the use of space satellites as an integral part of the CNI system.

The economical use of the spectrum can be best served if competitive space and airborne CNI planning is avoided. By initially proposing frequency plans that include allocations for space satellites as an adjunct to the second generation CNI system, a much broader base of support will become available from both the civil aeronautical and civil maritime communities.

6.1.7 An attractive arrangement for the second generation Aeronautical/Maritime CNI service would be to combine it with a space satellite CNI service, on a contiguous basis, using the 1535 MHz-1660 MHz band on an exclusive basis, as follows:

| USE | PORTION OF BAND USED |
|---|---|
| SPACE CNI - UP LINK | HIGH END |
| AIRBORNE CNI - UP LINK | HIGHER MIDDLE |
| AIRBORNE CNI - DOWN LINK | LOWER MIDDLE |
| SPACE CNI - DOWN LINK | LOW END |

However, allocation adjustments would need to be made for radar altimeters, collision avoidance and glide path systems now using small portions of this band.

6.1.8 The proposals of the United States for consideration at the 1971 ITU World Administrative Radio Conference for Space Telecommunications for the 1535 MHz-1660 MHz portion of the spectrum are substantially capable of interpretation in accordance with the conclusion stated immediately above.

6.1.9 The first formal international radio frequency spectrum allocation for CNI should be proposed by the U. S. at the second ITU World Administrative Radio Conference held in the 1970-80 decade. Such a World Conference could occur as early as 1974. The elaborate preliminary work that is involved in this process makes the immediate initiation of this work mandatory. The U. S. military must shortly resolve its joint position on CNI frequency planning, and thereafter concentrate upon winning the support of all interested agencies within the government as well as in the civil side of the house.

## 6.2 Recommendations

It is recommended that:

6.2.1 The initial frequency allocation plan for CNI should be concentrated upon the 960 MHz-1215 MHz portion of the spectrum, on a basis which permits TACAN and VOR-TAC to continue.

6.2.2 The present studies relating to electromagnetic compatibility of CNI, TACAN and VOR-TAC in the 960 MHz-1215 MHz band should be continued.

6.2.3 The frequency allocation plan for the second generation CNI should be directed toward use of the 1535 MHz-1660 MHz portion of the spectrum, in a system in which aeronautical, maritime, land based and space satellite transmitters and receivers are to be linked.

6.2.4 The United States position for the second ITU World Administrative Radio Conference of the 1970-1980 decade should include proposals for CNI in both the 960 MHz-1215 MHz and 1535 MHz-1660 MHz portions of the spectrum. These positions should be developed without delay, as a concerted effort by all interested parties, civil and governmental.

APPENDIX

EXCERPTS FROM THE 1968 ITU RADIO REGULATIONS

# RADIO REGULATIONS

## ADDITIONAL RADIO REGULATIONS

## RESOLUTIONS AND RECOMMENDATIONS

**(Edition of 1968)**

General Secretariat of the
International Telecommunication Union
GENEVA

# FOREWORD

1. This edition of the Radio Regulations has been published, after consulting the Administrations of countries Members of the ITU, in pursuance of Recommendation No. Mar 1 of the World Administrative Radio Conference to deal with matters relating to the Maritime Mobile Service, Geneva, 1967.

2. It takes into account the partial revisions of the Radio Regulations (Geneva, 1959) made by:

*a)* The Extraordinary Administrative Radio Conference to allocate frequency bands for Space Radiocommunication purposes, Geneva, 1963 (referred to hereafter as «the Space Conference»);

*b)* the Extraordinary Administrative Radio Conference for the preparation of a revised allotment plan for the Aeronautical Mobile (R) Service, Geneva, 1966 (referred to hereafter as «the Aeronautical Conference»);

*c)* the World Administrative Radio Conference to deal with matters relating to the Maritime Mobile Service, Geneva, 1967 (referred to hereafter as «the Maritime Conference»).

The final signature clauses (Nos. **1632** and **2165**), the signatures themselves which follow the Radio Regulations (Geneva, 1959), and the text of the Additional Protocol to those Regulations have not been reproduced; nor have the signatures and the texts of the Additional Protocols contained in the Final Acts of the Space Conference and the Aeronautical Conference, and the signatures and text of the Final Protocol included in the Final Acts of the Maritime Conference. To consult these texts, reference should be made to the volume containing the 1959 Radio Regulations and to the Final Acts of the afore-mentioned Conferences, which also contain the signatures.



# CHAPTER I

# Terminology

## ARTICLE 1

### Terms and Definitions

#### Preamble

**1** For the purposes of these Regulations, the following terms shall have the meanings defined below. These terms and definitions do not, however, necessarily apply for other purposes.

#### Section I. General Terms

**2** *Telecommunication:* Any transmission, emission or reception of signs, signals, writing, images and sounds or intelligence of any nature by wire, radio, visual or other electromagnetic systems.

**3** *General Network of Telecommunication Channels:* The whole of the existing telecommunication channels open to public correspondence, with the exception of the telecommunication channels of the mobile service.

**4** *Simplex Operation:* Operating method in which transmission is made possible alternately in each direction, for example, by means of manual control.[1]

**5** *Duplex Operation:* Operating method in which transmission is possible simultaneously in both directions.[1]

**6** *Semi-duplex Operation:* Operating method which is simplex at one end of the circuit and duplex at the other.[1]

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**4.1** [1] In general, duplex and semi-duplex operation require two frequencies in radiocommunication; simplex may use either one or two.

7 *Radio Waves (or Hertzian Waves):* Electromagnetic waves of frequencies lower than 3 000 Gc/s, propagated in space without artificial guide.

8 *Radio:* A general term applied to the use of radio waves.

9 *Radiocommunication:* Telecommunication by means of radio waves.

10 *Telegraphy:* A system of telecommunication which is concerned in any process providing transmission and reproduction at a distance of documentary matter, such as written or printed matter or fixed images, or the reproduction at a distance of any kind of information in such a form. The foregoing definition appears in the Convention, but, for the purposes of these Regulations, telegraphy shall mean, unless otherwise specified, "A system of telecommunication for the transmission of written matter by the use of a signal code".

11 *Frequency-Shift Telegraphy:* Telegraphy by frequency modulation in which the telegraph signal shifts the frequency of the carrier between predetermined values. There is phase continuity during the shift from one frequency to the other.

12 *Four-Frequency Diplex Telegraphy:* Frequency-shift telegraphy in which each of the four possible signal combinations corresponding to two telegraph channels is represented by a separate frequency.

13 *Telegram:* Written matter intended to be transmitted by telegraphy for delivery to an addressee; this term also includes radiotelegram unless otherwise specified. In this definition the term Telegraphy has the meaning defined in the Convention.

14 *Radiotelegram:* Telegram originating in or intended for a mobile station transmitted, on all or part of its route, over the radiocommunication channels of a mobile service.

15 *Telemetering:* The use of telecommunication for automatically indicating or recording measurements at a distance from the measuring instrument.



16 *Radiotelemetering:* Telemetering by means of radio waves.

17 *Telephony:* A system of telecommunication set up for the transmission of speech or, in some cases, other sounds.

18 *Radiotelephone Call:* A telephone call, originating in or intended for a mobile station, transmitted on all or part of its route over the radiocommunication channels of a mobile service.

19 *Television:* A system of telecommunication for the transmission of transient images of fixed or moving objects.

20 *Facsimile:* A system of telecommunication for the transmission of fixed images, with or without half-tones, with a view to their reproduction in a permanent form.

### Section II. Radio Systems, Services and Stations

21 *Station:* One or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radiocommunication service. Each station shall be classified by the service in which it operates permanently or temporarily.

22 *Fixed Service:* A service of radiocommunication between specified fixed points.

23 *Fixed Station:* A station in the fixed service.

24 *Aeronautical Fixed Service:* A fixed service intended for the transmission of information relating to air navigation, preparation for and safety of flight.

25 *Aeronautical Fixed Station:* A station in the aeronautical fixed service.

26 *Tropospheric Scatter:* The propagation of radio waves by scattering as a result of irregularities or discontinuities in the physical properties of the troposphere.

**27** *Ionospheric Scatter:* The propagation of radio waves by scattering as a result of irregularities or discontinuities in the ionization of the ionosphere.

**28** *Broadcasting Service:* A radiocommunication service in which the transmissions are intended for direct reception by the general public. This service may include sound transmissions, television transmissions or other types of transmissions.

**29** *Broadcasting Station:* A station in the broadcasting service.

**30** *Mobile Service:* A service of radiocommunication between mobile and land stations, or between mobile stations.

**31** *Land Station:* A station in the mobile service not intended to be used while in motion.

**32** *Mobile Station:* A station in the mobile service intended to be used while in motion or during halts at unspecified points.

**33** *Aeronautical Mobile Service:* A mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may also participate.

**34** *Aeronautical Station:* A land station in the aeronautical mo-
Spa bile service. In certain instances an aeronautical station may be placed on board a ship or an earth satellite.

**35** *Aircraft Station:* A mobile station in the aeronautical mobile
Spa service on board an aircraft or an air-space vehicle.

**36** *Maritime Mobile Service:* A mobile service between coast stations and ship stations, or between ship stations, in which survival craft stations may also participate.

**37** *Port Operations Service:* A maritime mobile service in or near
Mar a port, between coast stations and ship stations, or between ship stations, in which messages are restricted to those relating to the operational handling, the movement and the safety of ships and, in emergency, to the safety of persons. Messages which are of a public correspondence nature shall be excluded.

**38** *Coast Station:* A land station in the maritime mobile service.

**38A** *Port Station:* A coast station in the port operations service.
Mar

**39** *Ship Station:* A mobile station in the maritime mobile service located on board a vessel, other than a survival craft, which is not permanently moored.

**40** *Ship's Emergency Transmitter:* A ship's transmitter to be used exclusively on a distress frequency for distress, urgency or safety purposes.

**41** *Survival Craft Station:* A mobile station in the maritime or aeronautical mobile service intended solely for survival purposes and located on any lifeboat, life-raft or other survival equipment.

**42** *Land Mobile Service:* A mobile service between base stations and land mobile stations, or between land mobile stations.

**43** *Base Station:* A land station in the land mobile service carrying on a service with land mobile stations.

**44** *Land Mobile Station:* A mobile station in the land mobile service capable of surface movement within the geographical limits of a country or continent.

**45** *Radiodetermination:* The determination of position, or the obtaining of information relating to position, by means of the propagation properties of radio waves.

**46** *Radiodetermination Service:* A service involving the use of radiodetermination.

**47** *Radiodetermination Station:* A station in the radiodetermination service.

**48** *Radionavigation:* Radiodetermination used for the purposes of navigation, including obstruction warning.

**49** *Radionavigation Service:* A radiodetermination service involving the use of radionavigation.

**50** *Radionavigation Land Station :* A station in the radionavigation service not intended to be used while in motion.

**51** *Radionavigation Mobile Station :* A station in the radionavigation service intended to be used while in motion or during halts at unspecified points.

**52** *Aeronautical Radionavigation Service :* A radionavigation service intended for the benefit of aircraft.

**53** *Maritime Radionavigation Service :* A radionavigation service intended for the benefit of ships.

**54** *Radiolocation :* Radiodetermination used for purposes other than those of radionavigation.

**55** *Radiolocation Service :* A radiodetermination service involving the use of radiolocation.

**56** *Radiolocation Land Station :* A station in the radiolocation service not intended to be used while in motion.

**57** *Radiolocation Mobile Station :* A station in the radiolocation service intended to be used while in motion or during halts at unspecified points.

**58** *Radar :* A radiodetermination system based on the comparison of reference signals with radio signals reflected, or re-transmitted, from the position to be determined.

**59** *Primary Radar :* A radiodetermination system based on the comparison of reference signals with radio signals reflected from the position to be determined.

**60** *Secondary Radar :* A radiodetermination system based on the comparison of reference signals with radio signals re-transmitted from the position to be determined.

**61** *Instrument Landing System (ILS) :* A radionavigation system which provides aircraft with horizontal and vertical guidance just before and during landing and, at certain fixed points, indicates the distance to the reference point of landing.

**62** *Instrument Landing System Localizer :* A system of horizontal guidance embodied in the instrument landing system which indicates the horizontal deviation of the aircraft from its optimum path of descent along the axis of the runway.

**63** *Instrument Landing System Glide Path :* A system of vertical guidance embodied in the instrument landing system which indicates the vertical deviation of the aircraft from its optimum path of descent.

**64** *Marker Beacon :* A transmitter in the aeronautical radionavigation service which radiates vertically a distinctive pattern for providing position information to aircraft.

**65** *Radio Altimeter :* A radionavigation equipment, on board an aircraft, which makes use of the reflection of radio waves from the ground to determine the height of the aircraft above the ground.

**66** *Radio Direction-Finding:* Radiodetermination using the reception of radio waves for the purpose of determining the direction of a station or object.

**67** *Radio Direction-Finding Station :* A radiodetermination station using radio direction-finding.

**68** *Radiobeacon Station :* A station in the radionavigation service the emissions of which are intended to enable a mobile station to determine its bearing or direction in relation to the radiobeacon station.

**68A** *Emergency Position-Indicating Radiobeacon Station:* A station
Mar in the mobile service the emissions of which are intended to facilitate search and rescue operations.

**69** *Safety Service :* A radiocommunication service used permanently or temporarily for the safeguarding of human life and property.

**70 – 73** SUP (Spa)

**74** *Radio Astronomy :* Astronomy based on the reception of radio waves of cosmic origin.

**75** *Radio Astronomy Service :* A service involving the use of radio astronomy.

**75A** *Radio Astronomy Station*

Spa A station in the radio astronomy service.

**76** *Meteorological Aids Service:* A radiocommunication service used for meteorological, including hydrological, observations and exploration.

**77** *Radiosonde:* An automatic radio transmitter in the meteorological aids service usually carried on an aircraft, free balloon, kite or parachute, and which transmits meteorological data.

**78** *Amateur Service:* A service of self-training, intercommunication and technical investigations carried on by amateurs, that is, by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest.

**79** *Amateur Station:* A station in the amateur service.

**80** *Standard Frequency Service:* A radiocommunication service for scientific, technical and other purposes, providing the transmission of specified frequencies of stated high precision, intended for general reception.

**81** *Standard Frequency Station:* A station in the standard frequency service.

**82** *Time Signal Service:* A radiocommunication service for the transmission of time signals of stated high precision, intended for general reception.

**83** *Experimental Station:* A station utilizing radio waves in experiments with a view to the development of science or technique. This definition does not include amateur stations.

**84** *Special Service:* A radiocommunication service, not otherwise defined in this Article, carried on exclusively for specific needs of general utility, and not open to public correspondence.

**84AA** *Terrestrial Service*

Spa Any radio service defined in these Regulations, other than a space service or the radio astronomy service.

**84AB** *Terrestrial Station*

Spa A station in a terrestrial service.





**Section IIA. Space Systems, Services and Stations**

**84AC** *Space Service*

Spa A radiocommunication service:

— between earth stations and space stations,

— or between space stations,

— or between earth stations when the signals are re-transmitted by space stations, or transmitted by reflection from objects in space, excluding reflection or scattering by the ionosphere or within the earth's atmosphere.

**84AD** *Earth Station*

Spa A station in the space service located either on the earth's surface, including on board a ship, or on board an aircraft.

**84AE** *Space Station*

Spa A station in the space service located on an object which is beyond, is intended to go beyond, or has been beyond, the major portion of the earth's atmosphere.

**84AF** *Space System*

Spa Any group of co-operating earth and space stations, providing a given space service and which, in certain cases, may use objects in space for the reflection of the radiocommunication signals.

**84AG** *Communication-Satellite Service*

Spa A space service:

— between earth stations, when using active or passive satellites for the exchange of communications of the fixed or mobile service, or

— between an earth station and stations on active satellites for the exchange of communications of the mobile service, with a view to their re-transmission to or from stations in the mobile service.

**84AH** *Communication-Satellite Earth Station*

**Spa** An earth station in the communication-satellite service.

**84AI** *Communication-Satellite Space Station*

**Spa** A space station in the communication-satellite service, on an earth satellite.

**84AJ** *Active Satellite*

**Spa** An earth satellite carrying a station intended to transmit or re-transmit radiocommunication signals.

**84AK** *Passive Satellite*

**Spa** An earth satellite intended to transmit radiocommunication signals by reflection.

**84AL** *Satellite System*

**Spa** Any group of co-operating stations providing a given space service and including one or more active or passive satellites.

**84AM** *Space Research Service*

**Spa** A space service in which spacecraft or other objects in space are used for scientific or technological research purposes.

**84AN** *Space Research Earth Station*

**Spa** An earth station in the space research service.

**84AO** *Space Research Space Station*

**Spa** A space station in the space research service.

**84AP** *Broadcasting-Satellite Service*

**Spa** A space service in which signals transmitted or re-transmitted by space stations, or transmitted by reflection from objects in orbit around the Earth, are intended for direct reception by the general public.





**84AQ** *Radionavigation-Satellite Service*

**Spa** A service using space stations on earth satellites for the purpose of radionavigation, including, in certain cases, transmission or re-transmission of supplementary information necessary for the operation of the radionavigation system.

**84AR** *Radionavigation-Satellite Earth Station*

**Spa** An earth station in the radionavigation-satellite service.

**84AS** *Radionavigation-Satellite Space Station*

**Spa** A space station in the radionavigation-satellite service, on an earth satellite.

**84AT** *Meteorological-Satellite Service*

**Spa** A space service in which the results of meteorological observations, made by instruments on earth satellites, are transmitted to earth stations by space stations on these satellites.

**84AU** *Meteorological-Satellite Earth Station*

**Spa** An earth station in the meteorological-satellite service.

**84AV** *Meteorological-Satellite Space Station*

**Spa** A space station in the meteorological-satellite service, on an earth satellite.

**84AW** *Space Telemetering*

**Spa** The use of telemetering for the transmission from a space station of results of measurements made in a spacecraft, including those relating to the functioning of the spacecraft.

**84AX** *Maintenance Space Telemetering*

**Spa** Space telemetering relating exclusively to the electrical and mechanical condition of a spacecraft and its equipment together with the condition of the environment of the spacecraft.

**84AY** *Space Telecommand*

Spa The use of radiocommunication for the transmission of signals to a space station to initiate, modify or terminate functions of the equipment on a space object, including the space station.

**84AZ** *Space Tracking*

Spa Determination of the orbit, velocity or instantaneous position of an object in space by means of radiodetermination, excluding primary radar, for the purpose of following the movement of the object.

### Section IIB. Space, Orbits and Types of Objects in Space

**84BA** *Deep Space*

Spa Space at distances from the Earth equal to or greater than the distance between the Earth and the Moon.

**84BB** *Orbit*

Spa The path in space described by the centre of mass of a satellite or other object in space.

**84BC** *Angle of Inclination of an Orbit*

Spa The acute angle between the plane containing an orbit and the plane of the earth's equator.

**84BD** *Period of an Object in Space*

Spa The time elapsing between two consecutive passages of an object in space through the same point on its closed orbit.

**84BE** *Altitude of the Apogee*

Spa Altitude above the surface of the Earth of the point on a closed orbit where a satellite is at its maximum distance from the centre of the Earth.





## CHAPTER II

# Frequencies

## ARTICLE 3

### General Rules for the Assignment and Use of Frequencies

**113** § 1. The Members and Associate Members of the Union agree that in assigning frequencies to stations which are capable of causing harmful interference to the services rendered by the stations of another country, such assignments are to be made in accordance with the Table of Frequency Allocations and other provisions of these Regulations.

**114** § 2. Any new assignment or any change of frequency or other
Spa basic characteristic of an existing assignment (see Appendix 1 or Appendix 1A) shall be made in such a way as to avoid causing harmful interference to services rendered by stations using frequencies assigned in accordance with the Table of Frequency Allocations in this Chapter and the other provisions of these Regulations, the characteristics of which assignments are recorded in the Master International Frequency Register.

**115** § 3. Administrations of the Members and Associate Members of the Union shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations given in this Chapter or the other provisions of these Regulations, except on the express condition that harmful interference shall not be caused to services carried on by stations operating in accordance with the provisions of the Convention and of these Regulations.

**116** § 4. The frequency assigned to a station of a given service shall be separated from the limits of the band allocated to this service in such a way that, taking account of the frequency band assigned to

a station, no harmful interference is caused to services to which frequency bands immediately adjoining are allocated.

116A Spa § 4A. For the purpose of resolving cases of harmful interference, the radio astronomy service shall be treated as a radiocommunication service. However, protection from services in other bands shall be afforded the radio astronomy service only to the extent that such services are afforded protection from each other.

117 § 5. Where, in adjacent Regions or sub-Regions, a band of frequencies is allocated to different services of the same category (see Section II of Article 5), the basic principle is the equality of right to operate. Accordingly, the stations of each service in one Region or sub-Region must operate so as not to cause harmful interference to services in the other Regions or sub-Regions.





## ARTICLE 4

### Special Agreements

118 § 1. Two or more Members or Associate Members of the Union may, in accordance with Article 44 of the Convention, conclude special agreements regarding the sub-allocation of bands of frequencies to the appropriate services of the participating countries.

119 § 2. Two or more Members or Associate Members of the Union may, in accordance with Article 44 of the Convention, conclude special agreements, as a result of a Conference to which all those Members and Associate Members of the Union affected have been invited, regarding the assignment of frequencies to those of their stations which participate in one or more specific services within the frequency bands allocated to these services by Article 5, either below 5 060 kc/s or above 27 500 kc/s, but not between those limits.

120 § 3. The Members and Associate Members of the Union may, in accordance with Article 44 of the Convention, conclude, on a world-wide basis, and as a result of a Conference to which all Members and Associate Members of the Union have been invited, special agreements concerning the assignment of frequencies to those of their stations participating in a specific service, on condition that such assignments are within the frequency bands allocated exclusively to that service in Article 5.

121 § 4. Special agreements concluded in accordance with the provisions of Nos. **118** to **120** shall not be in conflict with any of the provisions of these Regulations.

122 § 5. The Secretary General shall be informed, in advance, of any Conference to be convened to conclude such an agreement; he shall also be informed of the terms of the agreement when concluded; and he shall inform the Members and Associate Members of the Union of the existence of such agreements.

123 § 6. In accordance with the provisions of Article 8 the International Frequency Registration Board may be invited to send representatives to participate in an advisory capacity in the preparation of these agreements and in the proceedings of the Conferences, it being recognized that in the majority of cases such participation is desirable.

124 § 7. If, besides the action they may take in accordance with No. **119,** two or more Members or Associate Members of the Union co-ordinate the use of individual frequencies in any of the frequency bands covered by Article 5 before notifying the frequency assignments concerned, they shall in all appropriate cases inform the Board of such co-ordination.





## ARTICLE 5

### Frequency Allocations
### 10 kc/s to 40 Gc/s

#### Section I. Regions and Areas

125 § 1. For the allocation of frequencies the world has been subdivided into three Regions [1] (see Appendix 24).

126 *Region 1 :*

Region 1 includes the area limited on the East by line A (lines A, B and C are defined below) and on the West by line B, excluding any of the territory of Iran which lies between these limits. It also includes that part of the territory of Turkey and the Union of Soviet Socialist Republics lying outside of these limits, the territory of the Mongolian People's Republic, and the area to the North of the U.S.S.R. which lies between lines A and C.

127 *Region 2 :*

Region 2 includes the area limited on the East by line B and on the West by line C.

128 *Region 3 :*

Region 3 includes the area limited on the East by line C and on the West by line A, except the territories of the Mongolian People's Republic, Turkey, the territory of the U.S.S.R. and the area to the North of the U.S.S.R. It also includes that part of the territory of Iran lying outside of those limits.

129 The lines A, B, and C are defined as follows :

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125·1 [1] It should be noted that where the words " regions " or " regional " are without a capital " R " in these Regulations, they do not relate to the three Regions here defined for purposes of frequency allocation.

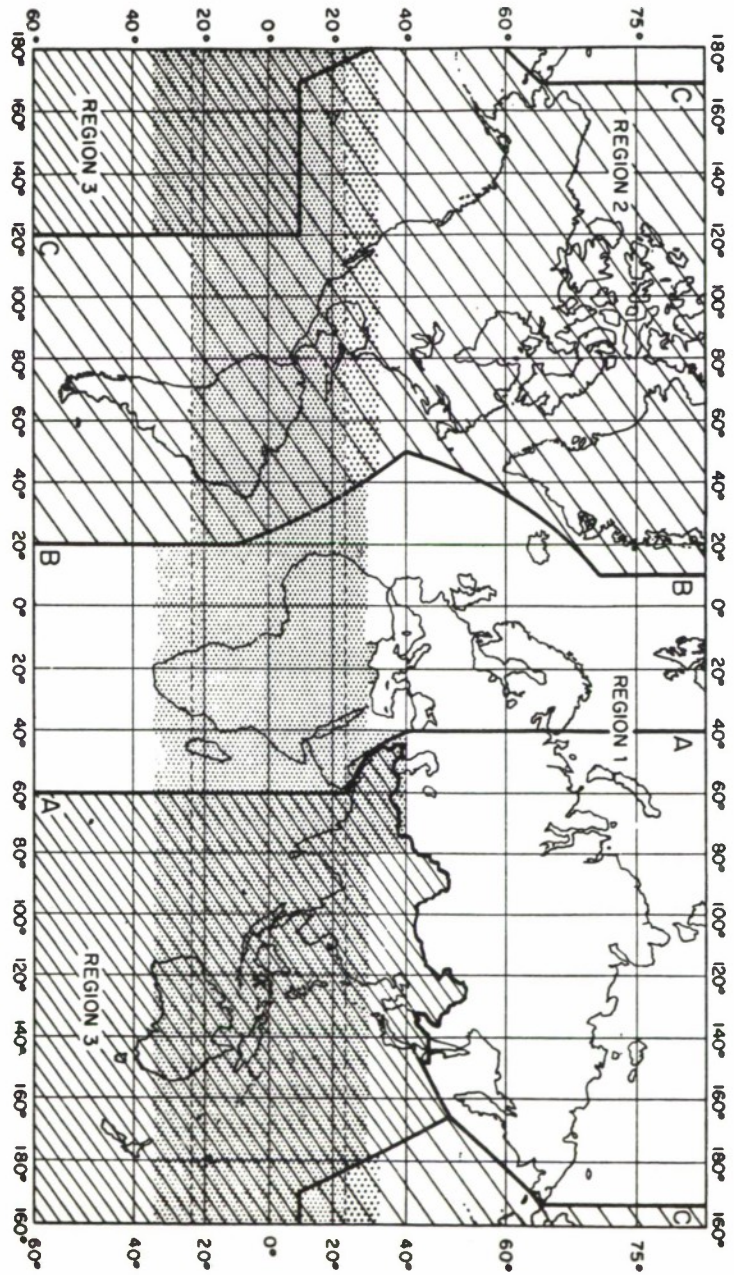


**Chart of Regions as Defined in Table of Frequency Allocations**

(See Nos. **125** to **132** and **135**)

The shaded part represents the Tropical Zone as defined in Nos. **135** and **136**

**130** *Line A :*

Line A extends from the North Pole along meridian 40° East of Greenwich to parallel 40° North ; thence by great circle arc to the intersection of meridian 60° East and the Tropic of Cancer ; thence along the meridian 60° East to the South Pole.

**131** *Line B :*

Line B extends from the North Pole along meridian 10° West of Greenwich to its intersection with parallel 72° North ; thence by great circle arc to the intersection of meridian 50° West and parallel 40° North ; thence by great circle arc to the intersection of meridian 20° West and parallel 10° South ; thence along meridian 20° West to the South Pole.

**132** *Line C :*

Line C extends from the North Pole by great circle arc to the intersection of parallel 65° 30′ North with the international boundary in Behring Strait ; thence by great circle arc to the intersection of meridian 165° East of Greenwich and parallel 50° North ; thence by great circle arc to the intersection of meridian 170° West and parallel 10° North ; thence along parallel 10° North to its intersection with meridian 120° West ; thence along meridian 120° West to the South Pole.

**133** § 2. The " European Broadcasting Area " is bounded on the West by the Western boundary of Region 1, on the East by the meridian 40° East of Greenwich and on the South by the parallel 30° North so as to include the western part of the U.S.S.R. and the territories bordering the Mediterranean, with the exception of the parts of Arabia and Saudi-Arabia included in this sector. In addition, Iraq is included in the European Broadcasting Area.

**134** The " European Maritime Area " is bounded on the North by a line extending along parallel 72° North from its intersection with meridian 55° East to its intersection with meridian 5° West,

then along meridian 5° West to its intersection with parallel 67° North, thence along parallel 67° North to its intersection with meridian 30° West; on the West by a line extending along meridian 30° West to its intersection with parallel 30° North; on the South by a line extending along parallel 30° North to its intersection with meridian 43° East; on the East by a line extending along meridian 43° East to its intersection with parallel 60° North, thence along parallel 60° North to its intersection with meridian 55° East and thence along meridian 55° East to its intersection with parallel 72° North.

**135** The "Tropical Zone" (see Appendix 24) is defined as:

*a)* the whole of that area in Region 2 between the Tropics of Cancer and Capricorn;

*b)* the whole of that area in Regions 1 and 3 contained between the parallels 30° North and 35° South with the addition of:

1) the area contained between the meridian 40° East and 80° East of Greenwich and the parallels 30° North and 40° North;

2) that part of Libya north of parallel 30° North.

**136** In Region 2, the Tropical Zone may be extended to parallel 33° North, subject to appropriate special agreements between the countries concerned in that Region.



### Section II. Categories of Services and Allocations

*Primary Services, Permitted Services and Secondary Services*

**137** Where, in a box of the Table in Section IV of this Article, a band is indicated as allocated to more than one service, either on a world-wide or Regional basis, such services are listed in the following order:



*a)* services, the names of which are printed in "small capitals" (example: FIXED); these services are called "primary" services;

*b)* services, the names of which are printed in "grotesque light" (example: Radiolocation); these are "permitted" services (see No. **138**);

*c)* services, the names of which are printed in "italics" (example: *Mobile*); these are "secondary" services (see No. **139**).

**138** Permitted and primary services have equal rights, except that, in the preparation of frequency plans, the primary service, as compared with the permitted service, shall have prior choice of frequencies.

**139** Stations of a secondary service:

*a)* shall not cause harmful interference to stations of primary or permitted services to which frequencies are already assigned or to which frequencies may be assigned at a later date;

*b)* cannot claim protection from harmful interference from stations of a primary or permitted service to which frequencies are already assigned or may be assigned at a later date;

*c)* can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.

**140** Where a band is indicated in a footnote to the Table as allocated to a service "on a secondary basis" in an area smaller than a Region, or in a particular country, this is a secondary service (see No. **139**).

141 Where a band is indicated in a footnote to the Table as allocated to a service "on a primary basis", or "on a permitted basis" in an area smaller than a Region, or in a particular country, this is a primary service or a permitted service only in that area or country (see No. **138**).

*Additional services*

142 Where a band is indicated in a footnote to the Table as "also allocated" to a service in an area smaller than a Region, or in a particular country, this is an "additional" service, i.e. a service which is added in this area or in this country to the service or services which are indicated in the Table (see No. **143**).

143 If the footnote does not include any restriction on an additional service apart from the restriction to operate only in a particular area or country, stations of this service shall have equality of right to operate with stations of the other service or services, the names of which are printed in "small capitals" in the Table.

144 If restrictions are imposed on an additional service in addition to the restriction to operate only in a particular area or country, this is indicated in the footnote to the Table.

*Alternative allocations*

145 Where a band is indicated in a footnote to the Table as "allocated" to one or more services in an area smaller than a Region, or in a particular country, this is an "alternative" allocation, i.e. an allocation which replaces, in this area or in this country, the allocation indicated in the Table (see No. **146**).

146 If the footnote does not include any restriction on stations of the service or services concerned, apart from the restriction to operate only in a particular area or country, these stations shall





have an equality of right to operate with stations of the service or services, the names of which are printed in "small capitals" in the Table, and to which the band is allocated in other areas or countries.

147 If restrictions are imposed on stations of a service to which an alternative allocation is made, in addition to the restriction to operate only in a particular country or area, this is indicated in the footnote.

*Miscellaneous Provisions*

148 Where it is indicated in these Regulations that a service may operate in a specific frequency band subject to not causing harmful interference, this means also that this service cannot claim protection from harmful interference caused by other services to which the band is allocated under Chapter II of these Regulations.

149 Except if otherwise specified in a footnote, the term "fixed service", where appearing in Section IV of this Article, does not include systems using ionospheric scatter propagation.

**Section III. Description of the Table of Frequency Allocations**

150 The heading of the Table in Section IV of this Article includes three columns, each of which corresponds to one of the Regions (see No. **125**). Where an allocation occupies the whole of the width of the Table or only one or two of the three columns, this is a world-wide allocation or a Regional allocation, respectively.

151 The frequency band referred to in each allocation is indicated in bold type in the left hand top corner of the part of the Table concerned.

152 Within each of the categories specified in No. **137**, services are listed in alphabetical order according to the French language. The order of listing does not indicate relative priority within each category.

153 The footnote references which appear in the Table below the allocated service or services apply to the whole of the allocation concerned.

154 The footnote references which appear to the right of the name of a service are applicable only to that particular service.

155 In certain cases, the names of countries appearing in the footnotes have been simplified in order to shorten the text.

**Section IV. Table of Frequency Allocations — 10 kc/s to 40 Gc/s**

156 This Table is shown on pages 40 to 121 following.





**Mc/s**
**108—143·6**
**(Spa)**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **108 — 117·975** AERONAUTICAL RADIONAVIGATION | | |
| **117·975—132** AERONAUTICAL MOBILE (R) 273 273A | | |
| **132—136** AERONAUTICAL MOBILE (R) 273A 274 275 | **132—136** FIXED MOBILE 273A 276 277 278 279 | |
| **136—137** FIXED MOBILE SPACE RESEARCH (Telemetering and tracking) 281A | **136—137** SPACE RESEARCH (Telemetering and tracking) 281A 281B | **136—137** FIXED MOBILE SPACE RESEARCH (Telemetering and tracking) 281A |
| **137—138** METEOROLOGICAL-SATELLITE SPACE RESEARCH (Telemetering and tracking) 281F SPACE (Telemetering and tracking) 275A 279A 281C 281D 281E | | |
| **138—143·6** AERONAUTICAL MOBILE (OR) 275 282 283 | **138—143·6** FIXED MOBILE Radiolocation | **138—143·6** FIXED MOBILE 278 279A 284 |

## Mc/s
## 143·6—144
## (Spa)

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **143·6—143·65** | **143·6—143·65** | **143·6—143·65** |
| AERONAUTICAL MOBILE (OR) | FIXED | FIXED |
| | MOBILE | MOBILE |
| SPACE RESEARCH (Telemetering and tracking) | SPACE RESEARCH (Telemetering and tracking) | SPACE RESEARCH (Telemetering and tracking) |
| 275 282 283 | Radiolocation | 278 279A 284 |
| **143·65—144** | **143·65—144** | **143·65—144** |
| AERONAUTICAL MOBILE (OR) | FIXED | FIXED |
| | MOBILE | MOBILE |
| 275 282 283 | Radiolocation | 278 279A 284 |

**273** The frequency 121.5 Mc/s is the aeronautical emergency frequency in this band; mobile stations of the maritime mobile service may communicate on this frequency for safety purposes with stations of the aeronautical mobile service.

**273A Spa** In the band 117·975-132 Mc/s and in the band 132-136 Mc/s where the aeronautical mobile (R) service is authorized, the use and development, for this service, of systems using space communication techniques may be authorized but limited initially to satellite relay stations of the aeronautical mobile (R) service. Such use and development shall be subject to co-ordination between administrations concerned and those having services operating in accordance with the Table, which may be affected.

**274** In certain countries of Region 1, the aeronautical mobile (OR) service will continue to operate for an unspecified period, on a primary basis.

**275 Spa** In Burundi, Ethiopia, Nigeria, Sierra Leone, Gambia, Portuguese Oversea Provinces in Region 1 south of the equator, Rhodesia and Nyasaland, Rwanda and the Rep. of South Africa and Territory of South-West Africa, the bands 132-136 Mc/s and 138-144 Mc/s are allocated to the fixed and mobile services.

**275A Spa** In Burundi, Nigeria, Sierra Leone, Gambia, Portuguese Oversea Provinces in Region 1 south of the equator, Rhodesia and Nyasaland, and Rwanda, the band 137-138 Mc/s is also allocated to the fixed and mobile services.

**276** In Region 2, in the band 132-135 Mc/s, the aeronautical mobile (R) service shall operate on a primary basis subject to co-ordination between administrations concerned and those having services operating in accordance with the Table, which may be affected.

**277** In Region 3, in the band 132-136 Mc/s, which will eventually become exclusively allocated to the aeronautical mobile (R) service, frequency assignments to the aeronautical mobile service shall be co-ordinated between administrations concerned and shall be protected from harmful interference.

**278 Spa** In New Zealand, the bands 132-136 Mc/s and 138-144 Mc/s are allocated to the aeronautical mobile (OR) service.

**279 Spa** In Australia, the band 132-136 Mc/s is allocated to the aeronautical mobile service.

**279A Spa** In Australia, the band 137-144 Mc/s is also allocated to the broadcasting service for television.

**280 281** SUP (Spa)

**281A Spa** For the use of the band 136-137 Mc/s, see Recommendation No. Spa7.

**281B Spa** In Region 2, the band 136-137 Mc/s is also allocated to the fixed and mobile services until 1 January, 1969. Thereafter, in Cuba, the band will continue to be allocated also to the fixed and mobile services.

**281C Spa** In Algeria, Bulgaria, Hungary, Kuwait, Lebanon, Morocco, Poland, the United Arab Republic, Yugoslavia, Roumania, Czechoslovakia and the U.S.S.R., the band 137-138 Mc/s is also allocated to the aeronautical mobile (OR) service. In the remaining countries of Region 1, the band 137-138 Mc/s is also allocated to the aeronautical mobile (OR) service until 1 January, 1969.

**281D Spa** In Norway, Switzerland and Turkey, the band 137-138 Mc/s is also allocated to the fixed service and mobile, except aeronautical mobile, service until 1 January, 1969.

**281E Spa** In Regions 2 and 3, the band 137-138 Mc/s is also allocated to the fixed and mobile services until 1 January, 1969. Thereafter, in Cuba, Malaysia, Pakistan and the Philippines, the band 137-138 Mc/s will continue to be allocated also to the fixed and mobile services.

**281F Spa** The band 137-138 Mc/s will be used mainly for research concerning the establishment, technical improvement, and maintenance of operational space systems.

**282 Spa** In Austria, the Netherlands and the United Kingdom, the band 138-144 Mc/s will, at some future date, be allocated to the fixed service and mobile, except aeronautical mobile, service.

**283 Spa** In Denmark, Greece, Norway, Portugal, F.R. of Germany, Sweden, Switzerland and Turkey, the band 138-144 Mc/s is also allocated to the fixed service and mobile, except aeronautical mobile (R), service.

**284 Spa** In China, the band 138-144 Mc/s is also allocated to the radiolocation service.

## Mc/s
## 144 — 150·05
## (Spa)

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **144—146**<br>AMATEUR<br>284A | | |
| **146—149·9**<br>FIXED<br>MOBILE except aeronautical mobile (R)<br>274 285 285A | **146—148**<br>AMATEUR<br>289 | |
| | **148—149·9**<br>FIXED<br>MOBILE<br>285A 290 | |
| **149·9—150·05**<br>RADIONAVIGATION-SATELLITE<br>285B | | |

**284A Spa** In the band 144-146 Mc/s, artificial satellites may be used by the amateur service.

**285 Spa** In Rhodesia and Nyasaland, and the Rep. of South Africa and Territory of South-West Africa, the bands 146-149·9 Mc/s and 150·05-174 Mc/s are also allocated to the aeronautical mobile service.

**285A Spa** The frequencies 148·25 Mc/s ±15 kc/s and 154·2 Mc/s±15 kc/s may be used for space telecommand, subject to agreement among the administrations concerned and those having services operating in accordance with the Table, which may be affected.

**285B Spa** Stations operating in the fixed and mobile services may continue to use this band until 1 January, 1969. This cessation date shall not apply in Austria, Bulgaria, Cuba, Hungary, Iran, Kuwait, Morocco, Pakistan, the Netherlands, Poland, the United Arab Republic, Yugoslavia and Roumania where the fixed and mobile services will continue to have equal primary status with the radionavigation-satellite service. (See Recommendation NoSpa8).

## Mc/s
## 150·05—174
## (Spa)

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **150·05—151**<br>FIXED<br>MOBILE except aeronautical mobile (R)<br>274 285 286 286A | **150·05—174**<br>FIXED<br>MOBILE | **150·05—170**<br>FIXED<br>MOBILE |
| **151—154**<br>FIXED<br>MOBILE except aeronautical mobile (R)<br>Meteorological aids<br>285 286 286A | | |
| **154—156**<br>FIXED<br>MOBILE except aeronautical mobile (R)<br>285 285A | | 285A 287 290 |
| **156—174**<br>FIXED<br>MOBILE except aeronautical mobile<br>285 287 288 | 285A 287 | **170—174**<br>FIXED<br>MOBILE<br>BROADCASTING |

**286 Spa** In Region 1, the band 150·05-153 Mc/s is also allocated to the radio astronomy service. In making assignments to new stations of other services to which this band is allocated, administrations are urged to take all practicable steps to protect radio astronomy observations from harmful interference.

**286A Spa** In the United Kingdom, the band 150·05-151 Mc/s is allocated to the radio astronomy service, and the band 151-153 Mc/s is allocated to the radio astronomy service on a primary basis and to the meteorological aids service on a secondary basis; however, in this band the provisions of No. **274** apply.

**287 Mar** The frequency 156·8 Mc/s is the international safety and calling frequency for the maritime mobile VHF radiotelephone service. Administrations shall ensure that a guard-band on each side of the frequency 156·8 Mc/s is provided. The conditions for the use of this frequency are contained in Article 35.

In the bands 156·025-157·425 Mc/s, 160·625-160·975 Mc/s and 161·475-162·025 Mc/s, each administration shall give priority to the maritime mobile service on only such frequencies as are assigned to stations of the maritime mobile service by that administration (see Article 35).

Any use of frequencies in these bands by stations of other services to which they are allocated should be avoided in areas where such use might cause harmful interference to the maritime mobile VHF radiotelephone service.

However, the frequency bands in which priority is given to the maritime mobile service may be used for radiotelephone communications on inland waterways, subject to agreements between interested and affected administrations and taking into account current frequency usage and existing agreements.

**288** In France, Morocco and Monaco, the band 162-174 Mc/s is allocated to the broadcasting service.

**289** In China, India and Japan, the band 146-148 Mc/s is also allocated to the fixed and mobile services.

**290 Spa** In New Zealand, the bands 148-149·9 Mc/s and 150·05-156 Mc/s are allocated to the aeronautical mobile (OR) service.

**Mc/s**

**174—235**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **174—216**<br>BROADCASTING<br>291 292 293 294 | **174—216**<br>FIXED<br>MOBILE<br>BROADCASTING<br>294 295 296 | |
| **216—223**<br>AERONAUTICAL RADIONAVIGATION<br>BROADCASTING<br>297 298 299 300 301 | **216—220**<br>FIXED<br>MOBILE<br>RADIOLOCATION | **216—225**<br>AERONAUTICAL RADIONAVIGATION<br>*Radiolocation* |
| **223—235**<br>AERONAUTICAL RADIONAVIGATION<br>*Fixed*<br>*Mobile*<br>299 300 301 302 303 304 305 | **220—225**<br>AMATEUR<br>RADIOLOCATION | 306 307 308 |
| | **225—235**<br>FIXED<br>MOBILE | **225—235**<br>FIXED<br>MOBILE<br>AERONAUTICAL RADIONAVIGATION |

**291** In the Union of South Africa and the Territory of South West Africa, the bands 174-181 Mc/s and 213-216 Mc/s are also allocated to the fixed and land mobile services.

**292** In the United Kingdom, the band 174-184 Mc/s is also allocated to the fixed service; the band 211-216 Mc/s is allocated to the broadcasting and aeronautical radionavigation services.

293 In Ethiopia, Kenya, Tanganyika, Uganda, Nigeria, Sierra Leone, Gambia, Rhodesia and Nyasaland, and Zanzibar, the band 174-216 Mc/s is also allocated to the fixed and mobile services.

294 Spa The band 183·1-184·1 Mc/s is also allocated, on a secondary basis, to the space research service.

295 In India, the band 197-216 Mc/s, and in New Zealand, Pakistan and the Philippines, the band 200-216 Mc/s are also allocated to the aeronautical radionavigation service.

296 In Australia, the band 202-209 Mc/s is allocated to the aeronautical radionavigation service.

297 The aeronautical radionavigation service will be operated only in Denmark, Spain, France, Greece, Nigeria, the Netherlands, Portugal, the United Kingdom, Sweden, Turkey and the Union of South Africa and Territory of South West Africa.

The broadcasting service will be introduced in such a way so as not to reduce the areas of coverage of the aeronautical radionavigation service of the above-mentioned countries existing on 21st December, 1959, or such lesser areas as may exist thereafter. The agreement of administrations concerned shall be obtained before new broadcasting stations are brought into operation which could cause harmful interference to the aeronautical radionavigation service.

The administrations employing the aeronautical radionavigation service shall not operate airborne equipment during flights over countries in which the band 216-223 Mc/s is used exclusively for the broadcasting service.

298 In Italy, the band 216-223 Mc/s is also allocated to the fixed service.

299 In France and in Italy, the provisions of No. **297** concerning the introduction of the broadcasting service apply to the band 216-225 Mc/s.

300 In the United Kingdom, the band 216-225 Mc/s is allocated to the aeronautical radionavigation and radiolocation services. The radiolocation service is a secondary service.

301 In Rhodesia and Nyasaland, the band 220-225 Mc/s is allocated to the amateur service.

302 In Austria and Switzerland, the band 223-230 Mc/s is allocated on a permitted basis to the broadcasting service; the band 230-235 Mc/s is allocated to the fixed and mobile services.

303 In Albania, Bulgaria, Hungary, Poland, Roumania, Czechoslovakia and the U.S.S.R., the band 223-230 Mc/s is allocated to the broadcasting service. The broadcasting service in these countries shall be introduced so as not to cause harmful interference to the aeronautical radionavigation service and broadcasting stations operating in this band shall be established only in accordance with agreements and associated plans to be concluded at the next European VHF/UHF Broadcasting Conference.

304 In the Union of South Africa and the Territory of South West Africa, the band 223-235 Mc/s is also allocated to the broadcasting service and the provisions of No. **297** concerning the introduction of that service will apply to this band.

305 In Nigeria, Sierra Leone and Gambia, the band 223-251 Mc/s is also allocated to the broadcasting service.

306 In Indonesia, the band 216-222 Mc/s is allocated to the fixed, mobile and broadcasting services.

307 In Japan, the band 216-222 Mc/s is allocated to the broadcasting service.

308 In China, Korea and the Philippines, the band 216-225 Mc/s is also allocated to the fixed and broadcasting services.

**Mc/s**
**235— 335·4–**
**(Spa)**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **235—267** | FIXED<br>MOBILE<br>305 309 | |
| **267—272** | FIXED<br>MOBILE<br>*Space* (Telemetering) | 309A 309B |
| **272—273** | FIXED<br>MOBILE<br>SPACE (Telemetering) | 309A |
| **273—328·6** | FIXED<br>MOBILE<br>310 | |
| **328·6 — 335·4** | AERONAUTICAL RADIONAVIGATION<br>310 | 311 |

**309** The frequency 243 Mc/s is the frequency in this band for use by survival craft stations and equipment used for survival purposes.

**309A Spa** Space stations employing frequencies in the band 267-273 Mc/s for telemetering purposes may also transmit tracking signals in the band.

**309B Spa** In the band 267-272 Mc/s individual administrations may use space telemetering in their countries on a primary basis, subject to the agreement of the administrations concerned and those having services operating in accordance with the Table, which may be affected.

**Mc/s**
**335,4—401**
**(Spa)**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **335·4—399·9** | FIXED<br>MOBILE | |
| **399·9—400·05** | RADIONAVIGATION-SATELLITE<br>311A | |
| **400·05—401** | METEOROLOGICAL AIDS<br>METEOROLOGICAL-SATELLITE (Maintenance telemetering)<br>SPACE RESEARCH (Telemetering and tracking)<br>312A 313 314 | |

**310** Radio astronomy observations on the Deuterium line (322-329 Mc/s) are carried out in a number of countries under national arrangements. Administrations should bear in mind the needs of the radio astronomy service in their future planning of this band.

**311** Limited to Instrument Landing Systems (glide path).

**311A Spa** Stations operating in the fixed and mobile services may continue to use this band until 1 January, 1969 This cessation date shall not apply in Bulgaria, Cuba, Greece, Hungary, Iran, Kuwait, Lebanon, Morocco, the United Arab Republic and Yugoslavia where the fixed and mobile services will continue to have equal status with the radionavigation-satellite service. (See Recommendation No Spa8)

**312** SUP (Spa)

**312A Spa** In Sweden, the band 400·05-401 Mc/s is also allocated to the fixed and mobile services until 1 January, 1966.

**313 Spa** In Albania, Bulgaria, Greece, Hungary, Poland, the United Arab Republic, Yugoslavia, Roumania, Czechoslovakia and the U.S.S.R., the band 400·05-401 Mc/s, is also allocated to the fixed and mobile services.

**314 Spa** In the United Kingdom, the band 400·05-420 Mc/s is also allocated to the radiolocation service; however, between 400·05 and 410 Mc/s the allocation to the radiolocation service is on a secondary basis.

**Mc/s**
**401 — 420**
**(Spa)**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **401—402** | METEOROLOGICAL AIDS<br>SPACE (Telemetering) 315A<br>*Fixed*<br>*Mobile* except aeronautical mobile<br>314 315 315B 316 | |
| **402—406** | METEOROLOGICAL AIDS<br>*Fixed*<br>*Mobile* except aeronautical mobile<br>314 315 316 317 | |
| **406 — 420** | FIXED<br>MOBILE except aeronautical mobile<br>314 317 | |

**315** In France, the band 401-406 Mc/s is allocated to the meteorological aids service.

**315A Spa** Space stations employing frequencies between 401-402 Mc/s for telemetering purposes may also transmit tracking signals in this band.

**315B Spa** In Australia, the space (telemetering) service in the band 401-402 Mc/s is a secondary service.

**316** In Albania, Bulgaria, Greece, Hungary, Iran, Norway, Poland, Yugoslavia, Roumania, Sweden, Switzerland, Czechoslovakia, Turkey and the U.S.S.R., the band 401-406 Mc/s is also allocated, on a primary basis, to the fixed service and mobile, except aeronautical mobile, service.

**317 Spa** The band 404-410 Mc/s in Region 2 and the band 406-410 Mc/s in Regions 1 and 3 are also allocated to the radio astronomy service. An appropriate continuous band within these limits shall be designated on a national or area basis. In making assignments to stations of other services to which these bands are allocated, administrations are urged to take all practicable steps to protect radio astronomy observations from harmful interference.

**Mc/s**
**420 — 470**
**(Spa)**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **420—430**<br>FIXED<br>MOBILE except aeronautical mobile<br>*Radiolocation*<br>318 319 | **420—450**<br>RADIOLOCATION<br>*Amateur* | |
| **430—440**<br>AMATEUR<br>RADIOLOCATION<br>318 319 320 321 322 | | |
| **440—450**<br>FIXED<br>MOBILE except aeronautical mobile<br>*Radiolocation*<br>318 319 319A | 318 319A 323 324 | |
| **450—460** | FIXED<br>MOBILE<br>318 319A | |
| **460—470** | FIXED<br>MOBILE<br>*Meteorological-Satellite* 318A | |

**318** Radio altimeters may also be used, temporarily, in the band 420-460 Mc/s until they are able to operate in a band allocated to the aeronautical radionavigation service or until they are no longer required.

**318A Spa** In Bulgaria, Cuba, Hungary, Poland, Roumania, Czechoslovakia and the U.S.S.R., the band 460-470 Mc/s may be used, on a primary basis, by the meteorological-satellite service subject to agreement among administrations concerned and those having services, or intending to introduce services, operating in accordance with the Table, which may be affected.

**319** In the United Kingdom, the band 420-450 Mc/s is allocated, on a primary basis to the radiolocation service and on a secondary basis to the amateur service.

**319A Spa** The band 449·75-450·25 Mc/s may be used for space telecommand, subject to agreement among the administrations concerned and those having services operating in accordance with the Table, which may be affected.

**320** In Greece, Italy and Switzerland, the band 430-440 Mc/s is also allocated to the fixed service and mobile, except aeronautical mobile, service.

**321** In Austria, Portugal, the F. R. of Germany, Yugoslavia and Switzerland, the frequency 433.92 Mc/s is designated for industrial, scientific and medical purposes. Emissions must be confined within the limits of ± 0.2% of that frequency.

**322** In Norway, the band 435-440 Mc/s is also allocated to the fixed service.

**323** In Indonesia, the band 420-450 Mc/s is also allocated, on a secondary basis to the fixed service and mobile, except aeronautical mobile, service.

**324** In Australia, the band 420-450 Mc/s is also allocated to the fixed service until the frequency assignments in this band for the fixed service stations are transferred to another band

**324A Spa** It is intended that meteorological-satellite space stations operating in this band shall transmit to selected earth stations. The location of such earth stations is subject to agreement among administrations concerned and those having services operating in accordance with the Table, which may be affected.

**Mc/s**
**470 — 942**
**( Spa )**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **470 — 582**<br>BROADCASTING | **470 — 890**<br>BROADCASTING | **470 — 585**<br>BROADCASTING<br>335 |
| **582 — 606**<br>BROADCASTING<br>RADIONAVIGATION<br>325 326 327 328 329 | | **585 — 610**<br>RADIONAVIGATION<br>336 337 |
| **606 — 790**<br>BROADCASTING<br>326 329 330 330A 331 332 | | **610 — 890**<br>FIXED<br>MOBILE<br>BROADCASTING |
| **790 — 890**<br>FIXED<br>BROADCASTING<br>329 331 333 334 | 332 | 332 338 339 |
| **890 — 942**<br>FIXED<br>BROADCASTING<br>*Radiolocation*<br>329 331 333 339A | **890 — 942**<br>FIXED<br>RADIOLOCATION<br>339A 340 | **890 — 942**<br>FIXED<br>MOBILE<br>BROADCASTING<br>*Radiolocation*<br>339 339A |

**Mc/s**

**942—960**

**(Spa)**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **942—960** | **942—960** | **942—960** |
| FIXED | FIXED | FIXED |
| BROADCASTING | | MOBILE |
| | | BROADCASTING |
| 329 331 333 339A | 339A | 338 339 339A |

325 In the United Kingdom, the band 582-606 Mc/s is allocated on a primary basis to the aeronautical radionavigation service and on a secondary basis to the radiolocation service.

326 In Italy, the band 582-685 Mc/s is also allocated to the fixed service until January, 1965.

327 In France and the F. R. of Germany, the band 582-606 Mc/s is allocated on a primary basis to the broadcasting service and on a secondary basis to the radionavigation service.

328 In Belgium, the band 582-606 Mc/s is allocated on a primary basis to the radionavigation service and on a secondary basis to the broadcasting service.

329 In Israel, the band 582-960 Mc/s is also allocated to the fixed service and mobile, except aeronautical mobile, service.

330 Spa In Region 1, except the African Broadcasting Area*, the radionavigation service may continue to operate in the band 606-610 Mc/s until the band is required for the broadcasting service.

330A Spa In the African Broadcasting Area*, the band 606-614 Mc/s is allocated to the radio astronomy service.

330.1 * For the purposes of this Regulation the term " African Broadcasting Area " means: Spa

*a)* African countries, parts of countries, territories and groups of territories situated between the parallels 40° South and 30° North.

*b)* Islands in the Indian Ocean west of meridian 60° East, situated between the parallel 40° South and the great circle arc joining the points 45° East, 11° 30′ North and 60° East, 15° North.

*c)* Islands in the Atlantic Ocean east of Line B defined in No. **131** of these Regulations, situated between the parallels 40° South and 30° North.

331 In Albania, Bulgaria, Hungary, Poland, Roumania, Czechoslovakia and the U.S.S.R., the band 645-960 Mc/s is also allocated to the aeronautical radionavigation service.

332 Spa In Region 1, except the African Broadcasting Area*, the band 606-614 Mc/s, and in Region 3, the band 610-614 Mc/s may be used by the radio astronomy service. Administrations shall avoid using the band concerned for the broadcasting service as long as possible, and thereafter, as far as practicable, shall avoid the use of such effective radiated powers as will cause harmful interference to radio astronomy observations.

In Region 2, the band 608-614 Mc/s is reserved exclusively for the radio astronomy service until the first Administrative Radio Conference after 1 January, 1974 which is competent to review this provision; however, this provision does not apply to Cuba.

333 In Region 1, stations of the fixed service using tropospheric scatter may operate in the band 790-960 Mc/s subject to agreements between the administrations concerned and affected. Such operations in the band 790-860 Mc/s shall be on a secondary basis to those of the broadcasting service.

334 In Belgium, France and Monaco, the band 790-860 Mc/s is allocated to the broadcasting service.

335 In Australia, the band 470-500 Mc/s is allocated to the fixed and mobile services.

336 In China, Korea, Japan and the Philippines, the band 585-610 Mc/s is also allocated to the broadcasting service.

337 In Australia, the band 585-610 Mc/s is allocated on a primary basis to the broadcasting service and on a secondary basis to the radionavigation service.

338 In Australia, the band 610-820 Mc/s is allocated to the broadcasting service; the bands 820-890 Mc/s and 942-960 Mc/s are allocated to the fixed service.

339 In India and Pakistan, the band 610-960 Mc/s is allocated to the broadcasting service.

339A Spa Specific portions of the frequency band 900-960 Mc/s may also be used, on a secondary basis, for experimental purposes in connection with space research.

340 In Region 2, the frequency 915 Mc/s is designated for industrial, scientific and medical purposes. Emissions must be confined within the limits of ± 25 Mc/s of that frequency. Radiocommunication services operating within those limits must accept any harmful interference that may be experienced from the operation of industrial, scientific and medical equipment.

* See No. **330.1**

**Mc/s**
**960—1 350**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **960—1 215** | AERONAUTICAL RADIONAVIGATION<br>341 | |
| **1 215—1 300** | RADIOLOCATION<br>*Amateur*<br>342 343 344 345 | |
| **1 300—1 350** | AERONAUTICAL RADIONAVIGATION 346<br>*Radiolocation*<br>347 348 | |

**341** Spa The band 960-1 215 Mc/s is reserved on a world-wide basis for the use and development of airborne electronic aids to air navigation and any directly associated ground-based facilities.

**342** In Albania, Bulgaria, Hungary, Poland, Roumania, Czechoslovakia and the U.S.S.R., the band 1 215-1 300 Mc/s is also allocated to the fixed service.

**343** In Belgium, France, Norway, the Netherlands, Portugal and Sweden, the band 1 215-1 300 Mc/s is also allocated to the radionavigation service.

**344** In China, India, Indonesia, Japan, Pakistan, Portuguese Oversea Provinces in Region 1 south of the equator, and in Switzerland, the band 1 215-1 300 Mc/s is also allocated to the fixed and mobile services.

**345** In the F. R. of Germany, the band 1 250-1 300 Mc/s is allocated to the amateur service.

**346** The use of the bands 1 300-1 350 Mc/s, 2 700-2 900 Mc/s and 9 000-9 200 Mc/s by the aeronautical radionavigation service is restricted to ground-based radars and, in the future, to associated airborne transponders which transmit only on frequencies in these bands and only when actuated by radars operating in the same band.

**347** In the United Kingdom, the band 1 300-1 350 Mc/s is allocated to the radiolocation service.

**348** In Albania, Austria, Bulgaria, Hungary, Indonesia, Poland, Roumania, Sweden, Switzerland, Czechoslovakia and the U.S.S.R., the band 1 300-1 350 Mc/s is also allocated to the fixed and mobile services.

**Mc/s**
**1 350—1 535**
**(Spa)**

<table>
<tr><th colspan="3">Allocation to Services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>1 350—1 400<br>FIXED<br>MOBILE<br>RADIOLOCATION<br>349</td><td colspan="2">1 350—1 400<br>RADIOLOCATION<br>349</td></tr>
<tr><td colspan="3">1 400—1 427<br>RADIO ASTRONOMY</td></tr>
<tr><td>1 427—1 429</td><td colspan="2">FIXED<br>MOBILE except aeronautical mobile<br>SPACE (Telecommand)</td></tr>
<tr><td>1 429—1 525<br>FIXED<br>MOBILE except aeronautical mobile</td><td>1 429—1 435<br>FIXED<br>MOBILE<br>1 435—1 525<br>MOBILE<br>Fixed</td><td>1 429—1 525<br>FIXED<br>MOBILE</td></tr>
<tr><td>1 525—1 535<br>FIXED 350B<br>SPACE (Telemetering) 350A<br>Mobile except aeronautical mobile 350C</td><td>1 525—1 535<br>SPACE (Telemetering) 350A<br>Fixed<br>Mobile 350D</td><td>1 525—1 535<br>FIXED 350B<br>SPACE (Telemetering) 350A<br>Mobile 350E</td></tr>
</table>

**349** In Region 2 and Albania, Bulgaria, Hungary, Poland, Roumania, Czechoslovakia and the U.S.S.R., the existing installations of the radionavigation service may continue to operate, temporarily, in the band 1 350-1 400 Mc/s.

**350** SUP (Spa)

**Mc/s**
**1 535 — 1 690**
**(Spa)**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **1 535—1 540** | SPACE (Telemetering) | |
| | 350A 351 352 352C | |
| **1 540—1 660** | AERONAUTICAL RADIONAVIGATION | |
| | 351 352 352A 352B 352D | |
| **1 660—1 664·4** | METEOROLOGICAL AIDS | |
| | METEOROLOGICAL-SATELLITE 324A | |
| | 353 354 354A 354B | |
| **1 664·4—1 668·4** | METEOROLOGICAL AIDS | |
| | METEOROLOGICAL-SATELLITE 324A | |
| | *Radio Astronomy* | |
| | 353 353A 354 354A 354B | |
| **1 668·4—1 670** | METEOROLOGICAL AIDS | |
| | METEOROLOGICAL-SATELLITE 324A | |
| | 353 354 354A 354B | |
| **1 670—1 690** | METEOROLOGICAL AIDS | |
| | FIXED | |
| | MOBILE except aeronautical mobile | |
| | 353 354 | |

**350A Spa** Space stations employing frequencies in the band 1 525-1 540 Mc/s for telemetering purposes may also transmit tracking signals in the band.

**Mc/s**
**1 690—1 700**
**(Spa)**

| Allocation to Services | | |
|---|---|---|
| Region 1 | Region 2 | Region 3 |
| **1 690—1 700** | **1 690—1 700** | |
| METEOROLOGICAL AIDS | METEOROLOGICAL AIDS | |
| METEQROLOGICAL-SATELLITE 324A | METEOROLOGICAL-SATELLITE 324A | |
| *Fixed* | | |
| *Mobile* except aeronautical mobile | | |
| 353 354A | 354A 354C | |

**350B Spa** As regards the category of the fixed service, see Resolution NoSpa3.

**350C Spa** In Albania, Bulgaria, France, Hungary, Kuwait, Lebanon, Morocco, Poland, the United Arab Republic, Yugoslavia, Roumania, Czechoslovakia and the U.S.S.R., the band 1 525-1 535 Mc/s is also allocated, on a primary basis, to the mobile, except aeronautical mobile, service. As regards the category of this service, see Resolution NoSpa3.

**350D Spa** In Cuba, the band 1 525-1 535 Mc/s is also allocated, on a primary basis, to the mobile service.

**350E Spa** In Japan, the band 1 525-1 535 Mc/s is also allocated to the mobile service, on a primary basis, until 1 January, 1969.

**351 Spa** In Italy, the band 1 535-1 600 Mc/s is also allocated to the fixed service until 1 January, 1970.

**352 Spa** In Albania, Bulgaria, Hungary, Poland, Roumania, Czechoslovakia and the U.S.S.R., the band 1 535-1 660 Mc/s is also allocated to the fixed service. As regards the category of the fixed service in the band 1 535-1 540 Mc/s, see Resolution NoSpa3.

**352A Spa** The bands 1 540-1 660 Mc/s, 4 200-4 400 Mc/s, 5 000-5 250 Mc/s and 15·4-15·7 Gc/s are reserved, on a world-wide basis, for the use and development of airborne electronic aids to air navigation and any directly associated ground-based or satellite-borne facilities.

352B Spa The bands 1 540-1 660 Mc/s, 5 000-5 250 Mc/s and 15·4-15·7 Gc/s are also allocated to the aeronautical mobile (R) service for the use and development of systems using space communication techniques. Such use and development is subject to agreement and co-ordination between administrations concerned and those having services operating in accordance with the Table, which may be affected.

352C Spa In Morocco and Yugoslavia, the band 1 535-1 540 Mc/s is also allocated to the aeronautical radionavigation service.

352D Spa In Austria, Indonesia and the F. R. of Germany, the band 1 540-1 660 Mc/s is also allocated to the fixed service.

353 In Austria and in Finland, the meteorological aids service is the primary service

353A Spa In view of the successful detection of two spectral lines in the region of 1 665 Mc/s and 1 667 Mc/s by astronomers, administrations are urged to give all practicable protection in the band 1 664·4-1 668·4 Mc/s for future research in radio astronomy.

354 In Albania, Bulgaria, Hungary, Poland, Roumania, Czechoslovakia and the U.S.S.R., the bands 1 660-1 690 Mc/s, 3 165-3 195 Mc/s, 4 800-4 810 Mc/s, 5 800-5 815 Mc/s and 8 680-8 700 Mc/s are also used for radio astronomy observations.

354A Spa In Algeria, Bulgaria, Cuba, Hungary, Kuwait, Lebanon, Morocco, Pakistan, Poland, the United Arab Republic, Yugoslavia, Roumania, Czechoslovakia and the U.S.S.R., the bands 1 660-1 670 Mc/s and 1 690-1 700 Mc/s are also allocated to the fixed service and the mobile, except aeronautical mobile, service.

354B Spa In Australia, Cyprus, Spain, Ethiopia, Indonesia, Israel, New Zealand, Portugal, the Spanish Provinces in Africa, the United Kingdom, Sweden and Switzerland, the band 1 660-1 670 Mc/s is also allocated, on a secondary basis, to the fixed service, and the mobile, except aeronautical mobile, service.

354C Spa In Australia, Indonesia and New Zealand, the band 1 690-1 700 Mc/s is also allocated, on a secondary basis, to the fixed service and the mobile, except aeronautical mobile, service.

355 SUP (Spa)

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13. ABSTRACT

Utilization of the radio frequency spectrum from 108 MHz to 1660 MHz for airborne radio navigation, air traffic control, and related communications and identification (CNI) purposes is examined with a view to identifying the most appropriate course of action to be followed in obtaining radio frequency allocations. On the basis of political, economic and electromagnetic compatibility considerations, combined with the necessity for the evolutionary introduction of CNI, an initial decision to concentrate TACAN operations on a lesser number of channels and reassigning the vacated spectrum space to CNI appears feasible in the 960-1215 MHz Aeronautical Radionavigation band. The 1535 MHz - 1660 MHz portion of the spectrum appears attractive for an ultimate consolidation of space/aeronautical mobile and CNI concepts. Formal frequency allocation action at the United States national level to support these judgments is urged.

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|---|---|---|---|---|---|---|
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| CNI | | | | | | |
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| ELECTROMAGNETIC RADIATION CONTROL | | | | | | |
| FREQUENCIES | | | | | | |
| GLOBAL COMMUNICATION | | | | | | |
| IDENTIFICATION FRIEND OR FOE | | | | | | |
| NAVIGATION | | | | | | |
| RADIO BROADCASTING | | | | | | |
| RADIO COMMUNICATION | | | | | | |
| RADIO FREQUENCIES | | | | | | |
| RADIOFREQUENCY INTERFERENCE | | | | | | |
| RADIO RECEPTION | | | | | | |
| RADIO TRANSMISSION | | | | | | |
| TELECOMMUNICATIONS | | | | | | |
| ULTRAHIGH FREQUENCIES | | | | | | |
| WIRELESS COMMUNICATION | | | | | | |